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THE EXTENSION OF TEMPORARY PASTURES IN ARABLE FARMING.[1]

Sir ROBERT GREIG, M.C., LL.D., D.Sc.

THIS subject has always bulked very largely in Scottish farming. When the English learned their better farming from the Dutch, and we Scots in turn learned it from the English, the introduction of those grasses and clovers from the Continent into England, and later into Scotland, brought about a very great improvement. In former days in Scotland the farmer cultivated his out-field until it would grow crops no longer; he then allowed the stubble to fall down into weeds and vegetation of various kinds, including our own national emblem and one or two importations from England, and his poverty-stricken cattle were maintained on this varied vegetation and herded by bare-legged children at a shilling or two a week.

When these so-called artificial grasses came in, so great an improvement was effected that until recently, at all events, there was in Scottish leases (though we paid no attention to it) a clause requiring a tenant sowing out his temporary grasses to use from 2½ to 3 bushels of perennial ryegrass an acre. That is an indication of how important it was thought to include the better-known of these grasses in the mixture.

The following remarks in regard to temporary pasture apply chiefly to Scottish farming. They are merely estimates of the trend and results of farming in Scotland over a period of years with a suggestion of how the systems now in vogue may be further developed. While up till recently they have been successful over a large part of Scotland, it is not suggested that they would be equally successful in every part of Scotland or England.

It has to be kept in mind that conditions of soil and climate are on the whole favourable to the growth of temporary pastures in Scotland and not on the whole favourable to the formation of first class permanent pasture. Moreover, in some parts of Scotland the fertility of the land for cropping could scarcely be maintained except through long rotations in which a store of plant food material is built up by the temporary pastures.

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[1] A full report of this paper, read by Sir Robert Greig at a meeting of the Farmers' Club in London in November 1930, along with a note of the subsequent discussion, has been published in the *Journal of the Farmers' Club*, Part 5, 1930. This article is based on that report and is published by kind permission of the Farmers' Club.

On this class of land also the best cannot be made of the pastures unless some land is kept under crop for winter keep. In short, such land cannot be most profitably farmed either as entirely arable or as entirely pasture. There are, however, wide limits to the methods of farming which may be adopted within this general procedure.

The importance of temporary pastures is evidenced by the interesting fact that during the last fifty years the live stock of Scotland has decreased in numbers in the purely pastoral areas and increased in the mainly arable areas. There has been a slight increase of stock over a 50-year period, viz., cattle 6·3 per cent., and sheep, 1·4 per cent., but as the following table shows the distribution has altered.

Period.	Counties of Argyll, Inverness, Ross and Cromarty, Sutherland, and Perth.			Remainder of Scotland.		
Average of:	Cattle.	Sheep.	Pigs.	Cattle.	Sheep.	Pigs.
1871–75 ...	246,524	3,082,712	28,263	880,813	4,078,409	137,885
1924–28 ...	218,136	2,383,224	20,860	979,781	4,875,808	157,258
	−28,388 or 11·5% decrease.	−699,488 or 22·7% decrease.	−7,403 or 26·2% decrease.	+98,968 or 11·2% increase.	+797,399 or 19·5% increase.	+19,373 or 14% increase.

In the counties which consist mainly of hill grazings and permanent pasture, viz., Argyll, Inverness, Ross and Cromarty, Sutherland and Perth, cattle have decreased 11 per cent. and sheep 22 per cent., while in the remainder of Scotland they have increased 11 per cent. and 19 per cent. respectively.

Looked at in more detail it is found that the cattle have increased mainly in the dairying districts of the south-west, while sheep have increased in the eastern or arable counties, in some cases to a remarkable extent. In Aberdeenshire, which is the largest arable county in Scotland, the sheep stocks have almost doubled, and in some other counties have increased by 50 per cent. Even in the Border counties, which always carried large sheep stocks, considerable increases are recorded.

The causes for this re-distribution of live stock are probably several, and need not be discussed now. The main point is that the arable farmer without laying down all his land to permanent grass has devoted more land, time and capital to stock. There is nothing new in this procedure, although the method has, perhaps, been adopted more widely in Scotland than in England. What are interesting are the effects upon production, profits and employment.

Production.—It is probable that the total production of Scotland in spite of the decrease of arable land is greater now than it was fifty years ago. The census of production of 1925 shows that, allowing for changes in values, the post-war production of Scottish agriculture is greater than the pre-war. It is, of course, arguable that it would have been still greater if more land had been maintained under the plough. During the last thirty years the total national production has tended to increase on arable farms with temporary pastures mainly in three ways: (*a*) more live stock has been sold off the farm; (*b*) the accumulated fertility due to the extension of temporary pastures in a longer rotation has produced heavier grain and root crops on a diminished acreage; (*c*) milk production has replaced ordinary mixed farming in many instances, and in more recent years poultry farming has appreciably added to farm receipts.

The first effect of the reduction of arable land and extension of pasture was not to increase production. Little was known fifty years ago, or even thirty years ago, about the laying down of pastures or the management of pasture, and it was the general experience that when the rotation was lengthened the pasture deteriorated as it became older, so that many three- and four-year-old pastures were full of weeds and moss, or partly bare of herbage. The full advantage was not, therefore, taken of the increased grass area, and the live stock, though more numerous than formerly, were not in proportion to the grass land available. The first stimulation to the improvement of temporary pastures in Scotland was given by Elliot of Cliftonbank, whose experiments with longer-lived and deeper-rooted grasses and other forage plants, though expensive, were definitely successful on some of the Border areas. Then followed the demonstration of the value of basic slag by Somerville and Middleton. This showed the deficiency of grazed land in phosphates, and the use of basic slag worked a revolution in the permanent pastures of England, particularly on certain types of land. Basic slag was less successful in Scotland, especially on temporary pastures, as the use of phosphatic fertilisers with the root crop helped to maintain the phosphate contents of the soil.

Following this were the experiments conducted by Findlay in the North of Scotland, showing the effects of different seed mixtures as demonstrated by both feeding and weighing tests. These experiments have had a great influence upon stock farming in Scotland. Then came the introduction of wild white clover by Professor Gilchrist, and this more than any other discovery improved the prospects of the mixed arable and stock farmer. It is not too much to say that in the North of Scotland many farms were raised a whole grade by wild white clover. Second class farms became first class, and third class second class, through the use of this clover.

The cumulative results of these improvements were to produce much heavier crops upon the arable land. The grain crops were further improved through the use of new varieties of grain, particularly oats, by the introductions from Sweden, Canada, and other places, and by the efforts of our British seed firms. Yields of oats in some districts have been nearly doubled; crops of 80 to 100 bushels per acre are sometimes harvested, and one of the most urgent requirements of Scottish farming is the introduction of a variety of oats which will stand the forcing treatment which is the effect of wild white clover and improved pasture management. Similarly, the new varieties of potatoes less susceptible to disease and stimulated by the accumulated humus of the pastures have greatly increased the yields per acre. On a smaller acreage the total crop of potatoes in Scotland is now on the average much larger than formerly. The lengthened rotation has also affected the turnip crop by reducing the liability to finger-and-toe disease.

As the pastures improved, not only were larger numbers of stock supported, but the stock was fattened off at earlier ages, making a quicker turnover. Where the arable farmer has taken to dairying he has been helped by the process of milk recording and hence higher yielding cows, and by information on better methods of feeding. The general effect, then, of reducing the arable land and increasing the pastures has been, *up till recently*, to provide a living, and in many cases more than a living, to the arable farmers, as shown by the steady demand for farms at increased rents or slight, if any, reductions.

We can summarise the position in regard to production as follows. There is more land under crops and grass in Scotland than there was fifty years ago. There is less arable land, indeed the area of arable land is now the smallest since returns were made in 1866, but while less wheat is produced than fifty years ago, more wheat is produced than thirty years ago.

Considerably less barley is produced, but on a diminished acreage more oats and potatoes are obtained, and more live stock and live stock products are sold. We had no census of production fifty years ago, but with the data available for pre-war and post-war production we can have little doubt that the post-war production of Scotland is as great if not greater than at any time before the war.

Employment.—The decrease in the number of workers employed on the land in Scotland is notable. Between 1851 and 1921 the census shows that the male agricultural workers declined by 33 per cent. But in the years from 1861 to 1871 the decline in numbers was nearly double that of any other ten year period. Now, from 1861 to 1871 and for ten years more the area of arable land in Scotland was steadily increasing. In short, in the thirty year period of prosperous farming and increasing cultivation, Scotland lost more male workers from the land than in the following thirty-year period of hard times and declining cultivation.

I have adopted Mark Twain's advice of first getting the facts and then distorting them as one pleases; but in spite of trying to distort them in various ways, I am forced to the conclusion that the assumption that more arable land means more employment is not borne out by the facts.

Mr. Senior, of the Department of Agriculture for Scotland, and formerly of the University of Reading, has shown by an investigation and by an examination of 130 farms in England and Scotland that the assumption that more arable land means more employment is not upheld. As the quantity of arable land increases, the average number of manual hours per acre also increases until the group of 40 per cent. to 50 per cent. of arable land is reached. Thereafter the labour employed does not increase, and in the group of farms having 90 per cent. to 100 per cent. arable less labour is employed per acre than in those groups having only 30 per cent. to 40 per cent. arable. Details of Mr. Senior's study cannot be given in this article, but roughly speaking, he finds that the more cattle the more employment, the more sheep the less employment, the smaller the farm the more employment, the larger the farm the less employment. The chief information to be obtained from this investigation, however, is that the amount of employment does not depend upon the amount of arable land, but upon the system of farming. A farm 50 per cent. arable may employ more men than one 100 per cent. arable, and a farm 20 per cent. arable may in some circumstances give more employment than one 40 per cent. arable. It depends on the use to which the grass and arable is put. In confirmation of these statements, I may say that a limited inquiry made by the Department seems to show that on an average mixed farm about 10 to 20 per cent. of a labourer's time is spent on the cultivation of crops for sale, the remaining time being expended in growing crops for stock food and in tending stock. Further confirmation comes from the extremely interesting fact that in the eight years 1921 to 1929 the arable land in Scotland has decreased 7 per cent., the cattle have increased 8 per cent., the sheep have increased 13 per cent., and the male workers employed have decreased by 30 individuals, that is to say, employment has been maintained and people have not been lost from the land. If, however, the arable area declined still further, if in short the whole country became pastoral, then there would of necessity be a reduction in the numbers of agricultural workers. Neither a purely ranching nor a purely cereal growing country can maintain a large agricultural population. The statistics of agricultural workers are the numbers given by the farmers themselves in the June Agricultural Returns, and it is apparent from these figures that, *up till recently* the systems of stock-raising and dairying adopted by Scottish farmers during the past twenty years have not tended to drive the agricultural labourer from the land. As stock farming in its various branches becomes more intensive, still less will the labourer be driven from the land. Stock farming to be intensively carried out must usually involve a proportion of land under cultivation, and it is the combination of temporary pastures with arable land that seems to offer the best prospect of employment for the future. We may say, then, with some confidence that the decline of arable land in Scotland has *up till recently* had little effect upon employment, and that the phenomenon of rural depopulation must be assigned to some other cause or causes than that.

Improvement.—It is therefore of importance to ascertain whether we can improve upon our present temporary and permanent pastures, particularly the former. About this I have no doubt, and here I may quote the opinion of a highly distinguished New Zealander who recently told me that from what he saw of England he thought that with the intensive improvement of our pastures, our live stock production could be doubled in five years. He added that after seeing the work in operation at the plant breeding station at Aberystwyth, he did not see how, under modern methods and modern organisation, New Zealand, Australia and Denmark could compete with us in butter-making or Canada in cheese-making. In his opinion everything was in our favour.

The improvements which we have been able to make to our pastures in Scotland have been due to the initiative of Scotsmen, but the work of the staffs of the Agricultural Departments at Aberystwyth and at Cambridge, to mention only two institutions, may result in even more valuable and far-reaching improvements. The possibilities of the use of pedigree and indigenous strains of pasture plants produced at Aberystwyth are difficult to estimate. If we judge them by palatability, persistency and yield of fodder, the results are remarkable. The pedigree strains of perennial ryegrass and cocksfoot, for instance, are more freely eaten by stock than the commercial strains, the yields of these grasses manured or unmanured are better from the pedigree than from the commercial strains. Under different systems of grazing management the indigenous cocksfoot is 50 per cent. more valuable than the commercial. When tested for persistency as judged by the number of tillers per unit of area an indigenous strain of cocksfoot is 14 times better than the commercial strain.

Professor Stapledon has further shown that good temporary leys sown with indigenous species show a high yielding ability when compared with really good permanent pastures on relatively similar soil types. By the use of simple but carefully balanced mixtures of grass and clover seeds temporary pastures have been produced equal to the Leicestershire fattening pastures. By different systems of management it has been shown that much has yet to be learned as to times, periods and methods of grazing calculated to obtain the best results. It would seem that when these and other improved strains of pasture plants are placed at our disposal great advances will be made. It is almost superfluous to remark upon the possibilities of new methods of intensive rotational grazing with the use of artificial manures. The general effects are familiar to all, but the following figures obtained by Imperial Chemical Industries' advisory and field staff are illuminating :—

> "From a complete costings analysis of the accounts at 97 dairy centres in the British Isles in 1928 (England and Wales, 40; Scotland, 14; Ireland, 43), the balance, being the difference between total costs per acre and returns per acre, was on the average £12, 6*s*. 10*d*.

"The actual payments received from the creameries, for the five Northern Ireland centres referred to above, were, *per acre*, as follows:—

	1927.	1928.		1929.
	Old System.	Old System.	Intensive System.	Intensive System.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Enniskillin	3 1 5	...	9 15 9	9 0 6
Aughaleague ...	...	4 2 10	...	15 15 10
Knockraven ...	...	1 16 10	...	6 12 6
Kesh	...	1 19 9	...	6 0 8
Newton Hamilton...	3 4 0	4 12 2 (Part time intensive)	...	5 17 9

Average for five centres (return for six months):—

Old System	£2 12 2
Intensive System	7 11 10

"The interpretation of these results calls for research. This is necessary not only to assign to different factors their relative importance, but also to suggest a line of attack for the small number of unsuccessful cases."[1]

The work of Woodman and others at Cambridge may eventually provide us with a new use for pasture in the form of grass cakes. The investigations proceeding at Cambridge and Aberdeen will show not only how pastures may be improved, but how the best use may be got from them by the supplementary feeding of stock.

In short, if much of the knowledge which is now available is focussed on grass land, the opinion of the New Zealander may be justified.

Hitherto our forefathers have regarded grass land as a convenient area on which to maintain live stock or even on which to fatten them in some cases. But grass land, we are beginning to find, is a highly complex crop, and because of its complexity it is capable of greater development under skilful control than such comparatively simple crops as wheat and potatoes.

There are difficulties attendant upon the production of temporary pastures in England, and as already stated the conditions on the whole are probably more favourable in Scotland. As it happens, owing to the fact that every county in Scotland comprises hill grazing, there is a certain balance between store stock farming and arable farming, which is favourable to the system described.

The opinion is frequently expressed that it is impossible to produce temporary pasture of good quality on some of the English stiff clays; but in view of the success of some temporary pastures on clays in Scotland, there seems reason to doubt this opinion. It is also stated that once a pasture is made on stiff clay the difficulty and expense of breaking it up when it deteriorates is almost insuperable; but this difficulty may yield to trial and experiment. We are no longer dependent on horse labour for the heaviest tasks of the farm, and it should be an easy matter by means of powerful tractors to break up any kind of land to a desired tilth, and in doing so to retain the high back ridges where they are still necessary.

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[1] **Extract from Paper read by Mr. Page at a Meeting of the British Association in Bristol, September 1930.**

Chalk and light sand are troublesome subjects, but they do grow grass now, and if grass grows it can be improved. It is reported that successful experiments are now being carried out on the thin soils of the wolds with their chalk substratum; and as we in Scotland have been able under very unfavourable conditions to produce grass, it should not be impossible to improve grass in England.

A further difficulty is the liability to droughts, particularly in the east of England, where there may for a time be no grass for stock, except on long established permanent pastures. It may be possible to meet this difficulty as in some other parts of the world by having silage crops, either green or preserved, to tide over such an emergency, though it is possible that the cost of growing crops for such a contingency may be prohibitive. A further objection that is made to temporary pasture is that while it does very well through spring and summer it does not finish cattle in the autumn so well as permanent grass. This difficulty is being countered in Scotland by growing green forage crops to feed to the grazing stock, thus supplying the proteins in which the temporary pastures have become deficient. It may be suggested that the extension of temporary pastures means the provision of more winter housing. In Scotland, where in some cases the carrying capacity of the pastures has outgrown the winter housing, it has been shown that stock will do even better outside than inside in the winter if sufficiently well fed, so that the number of stock is limited not by the housing available, but by the supply of winter keep.

With the exception of Ireland we have the finest climate in Europe for the growth of grass, and we have a market for live stock and live stock products in Great Britain which we can never fully supply in our time. It is by the intensive—not the extensive—use of grass land in rotation that we shall make the most progress.

If one were to draw a very general and approximate deduction from the signs of the times it would appear that the cereal grower on land which it would be a misfortune to return to grass should adopt the extensive colonial method of grain growing, that is to say, the almost continuous growth of grain over large fields with modern machinery, and no live stock or the minimum of live stock. The mixed farmer on the other hand should apparently adopt the continental method of intensive grass farming, with the growth of cereals as a bye product in the production of live stock and live stock products.

THE FUTURE OF CORN GROWING.

Professor J. A. S. Watson, M.C., B.Sc.,
School of Rural Economy, Oxford; and
A. Bridges, M.A.,
Agricultural Economics Research Institute, Oxford.

During the past year cereal prices have suffered a new and severe fall and they are now, on the whole, below pre-war level. Current world prices imply losses, more or less severe, to a majority of growers; and since in the long run the grower must have a margin over production costs, it is quite certain that the present situation cannot last. Either prices must rise or costs must be reduced. But strenuous and determined efforts in the latter direction are being made by our chief overseas competitors, and the important question for the future is how far these competitors will be able to cut their costs and how far we in turn shall be able to reduce ours.

It is a common view that the essence of the present depression in British agriculture is to be found in the disproportion that obtains between wages and prices. It is, of course, true that agricultural wages are still some 70 per cent. above pre-war level, whereas the general index of agricultural prices is only 29 per cent. up and that for cereals is about 6 per cent. down; also it is true that our markets are open to unrestricted competition on the part of the farmers of the continent of Europe, who get, or give, their labour at a much lower price than we get ours. But as regards grain the weight of competition has come, for the past half century, from countries where wages are not lower, but far higher than our own—namely, the United States, Canada, Australia and the Argentine. Moreover, there is no doubt that competition from these countries will remain in the future the most important factor in the situation. Low wage countries are feeling this competition almost as severely as ourselves, and are maintaining their cereal production only by means of very substantial measures of protection. In the case of wheat, for example, France has raised her tariff, during the past seven years, from about 10*s*. to about 30*s*. per quarter. The Italian import duty is approximately at the latter figure, while the German is substantially higher.

Mechanised Corn Farming Overseas.—The developments which brought about the fall in grain prices during the eighties and nineties of last century are well understood. Ocean transport was speeded up and cheapened, railways were built over great stretches of previously undeveloped land, and the invention of the binder made it possible for a man to handle a greatly increased acreage. At present it would seem that, under the influence of further mechanisation, a new era of expansion of grain farming has begun, and that the consequences to the farmers of the old countries will be scarcely less important than those which followed the introduction of the binder.

Wheat is the grain of greatest importance in world trade, and North America is the largest wheat-exporting area. It is convenient, therefore, to illustrate recent developments by reference to this crop in Canada and the United States. The year 1925 may be taken as a starting point. By that time the violent price fluctuations that were caused by war conditions had ceased and it appeared that a certain degree of stability in production had been reached.

The chief wheat areas of Canada lie in the prairie provinces—Manitoba, Saskatchewan and Alberta, these having about 96 per cent. of the total wheat acreage of the Dominion. In the United States there are two main areas : the hard spring-wheat belt embraces the States of Montana, North and South Dakota, and the hard winter-wheat belt comprises Kansas, Oklahoma, Nebraska, Texas and Colorado. These two belts contribute 70 per cent. of the wheat area of the whole country. The following statistics indicate the trend of production in the areas in question.

	Area under wheat in thousands of acres.		
	1925.	1929.	Increase.
1. Three Prairie provinces of Canada ...	19,759	24,307	4,548
2. Hard spring-wheat belt of U.S.A. ...	18,713	19,022	309
3. Hard winter-wheat belt of U.S.A. ...	22,346	25,715	3,369

The total expansion in four years is thus over eight million acres. This is equivalent to 14 per cent. of the 1925 area. It is also equal to six times the present wheat acreage of Great Britain and Ireland. This expansion of wheat cultivation has taken place without any corresponding increase in the world demand and in face of declining prices. It is only to be explained by the fact that methods have been evolved which have made possible a very marked reduction in costs.

The use of new types of machinery has been the dominating influence in this direction. Large oil-driven tractors and "combines" which cut and thresh the standing crop in one operation are now being used in large numbers. The building of good roads and the use of motor lorries for transport have also had an influence by bringing more land within reach of markets.

The use of tractors became general in North America nearly ten years ago. Since then great improvements have been made in their design, and they are now regarded as indispensable parts of the equipment of the ordinary farm. In 1925 there were 507,000 in the United States, and three years later the number had risen to 853,000. It is believed that the increase has continued right up to the present year. In Canada a similar development has occurred. Work horses are rapidly declining in numbers in face of the competition of efficient tractors and cheap fuel. Horseless farms are now numerous.

The combined harvester-thresher which has been used in certain areas for many years was the next logical step in the process of mechanisation. In 1929 it was estimated that more than half of the hard winter wheat and one-fifth of the hard spring wheat of the United States were harvested by combine.[1]

Before the use of tractors and combines became general the critical periods of labour requirements upon grain farms were those of sowing and harvesting. The acreage which a farmer could handle depended primarily upon the number of horses available at the time when the land was being tilled and sown and the amount of casual labour which could be obtained for harvest. Under mechanical farming the pressure of work at these two vital periods has been greatly eased. The tractor makes possible quicker, more efficient and cheaper tillage. The following cost figures [2] for a North Dakota farm indicate the amount of the financial savings :—

	Horses.	Tractors.	Saving.
	s. d.	s d.	
Ploughing	6 6	3 10	41 per cent.
Harrowing	0 6·5	0 2·7	57 ,,
Cultivating	2 5	0 10·3	65 ,,

The combine harvester has eliminated the binder (and thus the use of twine), the labour of stooking and stacking, and the additional handling involved in threshing. As a result it is generally admitted that costs of harvesting have been reduced to a small fraction of what they were. The number of highly paid casual workers required during the harvest has been reduced by 50 to 75 per cent. In Oklahoma it has been estimated that 100,000 men were thrown out of harvest employment in 1930.[3]

A further result of the use of power machinery is seen in the tendency for the size of farms to increase. In 1915 there were about 35,000 wheat farms in Montana. Now there are approximately 15,000, but the total acreage and output of wheat have meanwhile both increased.[4] Where opportunities occur farmers are taking up additional land so as to secure the more economical use of their machinery and the spreading of their overhead charges. These larger farms are still mostly of the one-family size,[5] but the typical family farm is now about a section (640 acres).

Under favourable conditions the labour cost under the new system is far below what is possible with other methods. In 1924-25 the average cost of producing wheat in the chief grain growing areas of North America ranged from 4*s*. 6*d*. to 5*s*. per bushel. In 1928 it was about 4*s*. a bushel. No present day costs for the same areas are available. Two recent authoritative statements may, however, serve to indicate the level of costs under mechanised conditions. Professor Grimes of the University of Kansas has stated that :—

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[1] United States Department of Agriculture Year Book, 1930, p. 18.

[2] *The Country Gentleman*, July 1930.

[3] *New York Times*, July 17, 1930.

[4] Wheat Studies of the Food Research Institute, Feb. 1930, p. 167.

[5] W. E. Grimes: Machine Production and the Price of Wheat. Paper read at International Conference of Agricultural Economists, August 1930.

> " Where full advantage of machine production has been taken, and the farm is large enough to permit maximum use of equipment, a few farmers have been able to reduce their costs so that a price of 50 cents (2*s*. 1*d*.) per bushel or less will give them customary rates of return on their land, labour and capital. Many farmers can be found who can produce profitably where the price of wheat is 60 or 70 cents (2*s*. 6*d*. or 2*s*. 11*d*.) a bushel." [1]

Mr. Hickman Price, one of the pioneers in mass production methods and now farming 30,000 acres in Texas, says :—" Our tests indicate that with 60 horse power tractors and correspondingly larger implements the cost per acre can be cut to $6 (25*s*.)." [2] He is expecting to be able to sell wheat with substantial profit at 50 cents (2*s*. 1*d*.) per bushel.

From these statements it would seem reasonable to suppose that costs of growing wheat have been halved by the newer methods. It may be noted in passing that a subsidiary but still important part of this result has been achieved by the introduction of higher yielding varieties.

The system of farm management followed in the areas in question is comparatively simple. Typically the farmer specializes in grain and keeps little or no live stock. The rotation consists of grain, with a bare fallow as frequently as is necessary. In the " dry farming " districts the fallow is taken every other year, not mainly as a measure of weed control but as a means of conserving moisture—" using two years' rain for one crop," In other districts the fallow may come every third year or even more seldom. Normally, however, a considerable area of fallow is necessary in order to spread out the operations of tillage and provide summer employment. Ploughing, cultivating, discing and harrowing are performed by means of 30 to 60 horse power tractors, and the ground is covered very quickly. It is not unusual, with a one man outfit, to plough 10 to 15 acres or to drill 50 acres per day. In periods of stress the tractors are worked day and night. In some districts small applications of artificials, chiefly superphosphate, are made; in others these are as yet unnecessary. At harvest, if the crop is free from green, succulent weeds, it is cut and threshed in one operation by means of the combine harvester. If the conditions do not favour this method the crop is cut and left in windrow for a day or two, when it is picked up and threshed by means of the combine. In this case the machine first employed is like a binder with an 8 to 10 ft. cut, but without the binding attachment. The grain is usually taken straight from the field to the elevator by motor lorry, which may be owned by the farmer or hired on contract for the purpose. The straw is commonly burnt; it can, however, be collected after the conclusion of the grain harvest by means of side delivery rakes, tractor sweeps and hay stackers.

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[1] Grimes, op. cit.

[2] Garner: Mass Production applied to the Country's largest individual Wheat Farming Operation, *Manufacturers' Record*, Aug. 7, 1930.

It is, of course, pertinent to ask whether such a system can possibly endure or whether it is to be regarded merely as a temporary process of land robbery. At first sight it must seem that the methods described can only be shortlived. But it must be remembered that the prairie soils, and still more those of the semi-arid regions, are much less easily exhausted than our own. It must also be remembered that a high yield per acre, according to our ideas of yield, is not expected, and even under British conditions it would seem that a yield of 20 bushels of wheat per acre can be maintained on certain types of soil, with light dressings of artificials and no dung. Besides, the supply of virgin land is very far from coming to an end. In the Western Great Plains region of the United States alone there are forty million acres of useful wheat land available for future development. In Canada the area awaiting exploitation is immense. Hence we must reckon with the continuance of this type of grain production for an indefinite period of time.

Possibilities in Britain.—That the system outlined above will require modification before it can be adopted in Britain goes without saying.

Firstly our British soils have, broadly speaking, a higher clay content than those of the prairie and semi-arid regions. They are stickier, and hence more easily damaged when in wet condition; and, of course, they are in wet condition over a far longer period of the year. It is well known that an ordinary wheel tractor is capable of doing considerably more damage to a wet soil than a pair of horses. It is only on our lighter and better drained soils that this point can be left out of consideration. It would, however, seem that the track laying (or caterpillar) type of tractor is much less objectionable than a wheeled tractor from this point of view. A really powerful tractor of this type, such as the 60 horse power "Caterpillar," weighs nearly nine tons, but the weight is spread over an area of some 17 square feet. The pressure is thus no more than 8 lb. per square inch of surface as against 15 or 20 lb. under an ordinary farm horse's hoof. As a fact the amount of soil disturbance caused by such a tractor is very small. It has the further advantage of a very small slip (with a consequent small loss of efficiency on soft ground), as well as that of handiness of turning. The main disadvantage of the older types, viz. the short life of the tracks, seems to have been largely overcome.

Regarding the possibility of using the combine harvester in Britain, two seasons' trials indicate that the difficulties to be surmounted are less serious than might have been expected. With crops in an ordinary state of ripeness, and no drier than is required for the efficient working of a binder, clean threshing can be secured from the standing crop. Where there is trouble with green grass or weeds in the crop the windrow method works well. It was anticipated that whereas British crops in an average season might be dry enough to thresh off the ground, the grain would rarely be dry enough to keep in bulk. Therefore for the 1929 trials the Oxford Engineering Institute constructed a drier through which the grain was to be passed immediately after threshing. During the dry harvest of 1929 the machine was hardly required, but during the last season driers of similar type have been used with highly satisfactory results. Indeed the artificial drying has proved a marked success; in one case it enabled the whole of a large area of barley to be secured in first class condition during one of the most difficult harvest seasons on record. It must be pointed out that the drying of the grain alone is a far simpler problem than that of drying the crop as a whole. Ripe grain in harvestable condition rarely contains more than 18 to 20 per cent. of water. To avoid all risk of heating it is necessary to reduce the moisture content to about 14 per cent. Thus at the worst the problem amounts to evaporating about one cwt. of water from each ton of grain, a task which can be accomplished at quite a small cost. Thus the combine harvester used in conjunction with a grain drier opens up the possibility of almost entirely eliminating the main risk of the British grain grower, namely, that of a wet harvest. Combining also eliminates almost entirely the loss from shedding of grain during harvest.

On the question of straw it is true that the existing types of combine, because they have been designed for countries where straw is practically worthless, cannot deal with a rank crop and leave a short stubble. But the necessary modifications could easily be made. The straw can be quickly and cheaply collected, as soon as it is dry, by means of modern haymaking machinery. It is difficult to say whether the straw, left loose upon the ground, will suffer more or less damage than it does in stook. With good weather the period required for winning will be considerably reduced.

In regard to the minimum size of unit for the economical working of the mechanised system it is difficult to give any precise information. It would, however, seem clear that the mechanised farm need not necessarily run into thousands of acres. Rather would it appear that the system could justify itself on a basis of 200 acres of grain, and that all the substantial advantages might be reaped with a grain area of 300 or 400 acres.

It will, of course, be sufficiently obvious that the introduction of the new system would involve, in the case of an established farmer, the scrapping of a large amount of existing plant, including horses and horse implements, binders, and in many cases an existing threshing mill. Several farmers in the grain growing districts of England have already made up their minds to face the sacrifice involved, but it is a serious one.

Mechanical methods can be fully applied only to two types of crop, viz. cereals and hay. Potatoes and roots do not lend themselves to the system. Hence full mechanisation must involve a measure of specialization. One possible line of development is to adopt a rotation including only grain, hay and bare fallow, to sell the whole of the produce, and to rely for the maintenance of fertility entirely upon artificial manures.

That this system will work upon certain soils, such as carse land and the Lincolnshire silts, is already known. But there is a rather strong presumption that on much of our land even a moderate level of fertility will not be maintained unless some regular method is adopted for maintaining the humus content of the soil. This will be less important where wheat and barley are the chief crops, more so where oats are the standard cereal. If the straw and hay are retained upon the farm to be converted into manure then the mechanical handling of dung will provide an additional problem. One other possibility is to leave the straw upon the ground, perhaps spraying it with sulphate of ammonia to ensure its rapid humification, and to plough it in. Hay aftermaths might also be used as green manures, and obviously a temporary pasture would largely solve the problem.

The seasonal distribution of labour under a specialised and mechanised system would require a good deal of thought. With fallows, hay, winter wheat and oats, spring oats and barley, full work might be provided for a regular staff from March to November inclusive, except perhaps in May. But without such standard winter jobs as root and dung carting, dung spreading and threshing, it is difficult to see how economical winter employment could be found. In the United States this situation is frankly accepted and the view taken that good wages for nine months or less are better than low wages for twelve.

In conclusion it is impossible to deny that mechanised methods of grain production have involved a large displacement of labour wherever they have been adopted, and there is no reason to suppose that their effect, in this country, would be different. The labour cost of fully mechanised corn growing is approximately one man day per acre, whereas the average figure in this country at present is probably between five and six man days. But if present prices of grain are to endure and the present wage level is to be maintained our choice for the future is not as between the old system of grain growing and the new. It is between the new system and the abandonment of corn production altogether.

THE NATIONAL IMPORTANCE OF STOCK FARMING.

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MANY different opinions are held as to what are the best means of improving the present position of agriculture and making the industry more prosperous. When considering the question it is important to bear in mind that there are several different branches of agriculture, and measures which would be beneficial to one branch might be of no value, or be even detrimental, to other branches. At the present time depression is most acute in cereal production, and attention tends to be centred on this branch of the industry, and especially upon wheat. Indeed, it is assumed by some that if wheat growing can be made to pay, the prosperity of agriculture is assured. Wheat, however, represents only about 5 per cent. of the agricultural production of this country, indeed all cereals represent only about 10 per cent., and it is doubtful whether the number of people engaged on the production of wheat and other cereals is greater than these percentages of the total agricultural population. There is a danger, therefore, that attention may be focussed too exclusively on wheat, resulting in a policy which, though satisfactory to the wheat grower, will confer little benefit upon the remaining 95 per cent. of the industry.

The present article contains no statement of policy, it is merely intended to emphasise the importance of stock-farming in our agriculture. In examining the position, it is important to note in the first place the relative money values of the different kinds of foodstuffs we are consuming. The wholesale cost of the food consumed in this country runs to about £15 per head. The following table analyses expenditure in the various classes of foodstuffs, taking £1 as unit :—

Animal Products :	
Meat, bacon, milk, butter, cheese, eggs, &c.	12*s*. 6*d*.
Cereals :	
Wheat, flour, oatmeal, barley, &c.	2*s*. 0*d*.
Fruit	1*s*. 9*d*.
Sugar	1*s*. 9*d*.
Potatoes and vegetables	1*s*. 3*d*.
Fish	0*s*. 9*d*.
	20*s*. 0*d*.

It is seen that cereals account for only one-tenth part of the nation's expenditure on food, whereas animal products account for more than half of the total expenditure. We produce at home 20 per cent. of the wheat and wheat flour we consume, over 50 per cent. of the barley, and over

80 per cent. of the oats. Even though we were self-supporting in these cereals, it would not mean much more than 1*s*. per £1 of our total expenditure on food. On the other hand, in animal products we produce rather less than 50 per cent. If these were all produced at home, the increased production would amount to over 6*s*., or nearly one-third of our total expenditure. It is clear, therefore, that if one of our objectives be to purchase from our own farmers what at present we are purchasing from abroad, stock farming has greater potentialities than cereal growing.

The following table shows the relative value of different branches of agriculture in the United Kingdom at the present time. The figures are calculated from the Agricultural Census of 1925. The total production in the United Kingdom runs to nearly £287,000,000, and (in round figures) is distributed as follows :—

Live stock and animal products	£205,000,000
Cereals	28,000,000
Other arable crops, including potatoes and sugar beet	29,000,000
Fruit, vegetables, flowers	25,000,000

It is seen that animals and animal products account for three-fourths of the total revenue. The predominant position of stock farming is even greater than is indicated by this fraction, because part of the remaining quarter is subsidiary to stock farming, a considerable portion of the cereals and other arable crops being disposed of as feed for stock.

We have seen that stock farming dominates British agriculture, and that the products of stock farming account for more than half of the national expenditure on food. Our own farms produce animal products to the value of about £200,000,000. In addition we import more than £200,000,000. Could our home production be increased? The main factors on which production depends are the number and efficiency of the animals and the supply of feeding-stuffs. We will not trouble about the numbers —these could easily be increased. What is more important is their efficiency, because in general the greater the efficiency of the animal (i.e. the faster the rate of growth or the higher the yield), the lower is the cost of production.

The average yield of milk cows in this country is about 500 gallons per annum, but there are thousands of cows with a yield of 1,000 gallons or over. The average yield is slowly rising and could easily be brought up to 700 or 800 gallons. Well-bred pigs, properly fed, should be ready for slaughter for bacon between 6 and 7 months old. A recent survey made from Cambridge University showed that there are still many farms where the animals were not ready for slaughter until they were 10 or, in some cases, even 11 months old. Poultry have improved very rapidly in recent years. Fifty years ago 50 to 100 eggs per hen per annum was probably about the average. To-day on good poultry farms the average is between 150 and 200 eggs, and there are several strains in which it is not uncommon to find the individual hens laying between 250 and 300 eggs in the year. There is thus still room for increased efficiency on the part of the hen. Beef cattle and sheep are also capable of improvement, though perhaps not to the same extent as dairy cows and pigs.

The means whereby animals can be rendered more efficient, viz. by selective breeding, especially by elimination of the inferior or "scrub" sire, by better methods of feeding and by the elimination of disease, are well known and are indeed being applied, though the progress being made is rather slow.

Increased production necessitates more feeding-stuffs, though if the increased production were to be brought about by greater efficiency rather than by greater numbers, the increased production would be out of all proportion to the extra feeding-stuffs required.

The main feeding-stuff for cattle and sheep is grass. During the last few years by the introduction of new pasture plants, by an increase in top-dressing and by better management, the feeding value of pastures has been increased. There is still room for improvement. Indeed, if the measures now being applied by the most progressive farmers were adopted universally, there would be, within the next ten years, an increase of 25 to 50 per cent. in the carrying capacity of our British pastures. The roughage and concentrates for a winter feed could easily be provided. The former would need to be produced at home. This would help to bring back into cultivation part of the four million acres of arable land which has gone out of cultivation in the last fifty years. There is no shortage of concentrates in the world. Our own colonies could supply us with all the concentrates necessary to feed double the number of farm animals in this country.

We have seen that there is no insuperable difficulty in increasing the home supply of animal products. Grading up the whole industry to the level of the most efficient would, in itself, increase the output by nearly 50 per cent., which would mean another £100,000,000 added to the revenue of agriculture.

It is in this direction that British agriculture is moving. During the last fifty years, when wheat growing has been steadily declining, stock farming has been increasing its output. The development is taking place to the extent and in the directions in which the industry is profitable. Thus even though we have to compete in our own market with all countries of the world, we have been able to maintain and indeed improve our position in stock farming. A very small impetus in the form of better prices or decreased cost of production would lead to rapid developments in the direction of capturing more and more of the market for over £200,000,000 of animal products which we are importing annually from over-seas.

Let us consider now arable farming. A great part of this, probably more than the half, is subsidiary to stock farming because the crops are used as feeding-stuffs. As stock farming is developed, this part of arable farming will be extended, but the farmer will look for his profit not from his grass, roots, silage, straw or grain fed to animals, but from his dairy produce, bacon, beef and eggs, which are end products of agriculture.

It is possible that in the past we have been too conservative in cropping for animal feeding-stuffs. For example, it is now known that green food is of special value for the health of stock, and it may be found that an extension of green cropping to come in as food in the autumn when the pastures are failing will be a profitable procedure. There are certain other crops which grow well in this country and are known to be valuable for feeding, and experiments designed to increase the range of crops in winter feeding are now being undertaken.

This question of the influence of intensive stock farming on cultivation was recently dealt with by Dr. Gordon of Northern Ireland, who put forward a view similar to that expressed here. He pointed out that in Denmark, where in the seventies there was a change over from arable farming to extensive stock farming, the area of cultivated land actually increased. In Denmark, according to Dr. Gordon, about seven-eighths of the feeding-stuffs are home grown.

We have seen that the conditions are favourable for the development of intensive stock farming and that this development would have an influence in increasing the land under cultivation. This branch of agriculture is already on the verge of being profitable. The output of the poultry industry, in which there is remarkable enthusiasm and enterprise, and which the Government has materially assisted by various means, has increased by about 50 per cent. in the last twenty years.

Let us now compare with stock farming the position of wheat growing. It is claimed that the English farmer would need 50*s*. to 55*s*. a quarter to make wheat growing profitable. Wheat can be grown in several parts of the world at a much lower cost. The Australian wheat grower asks for a guaranteed price of 32*s*. It is recognised that under our present system it is impossible for the English wheat farmer to compete in the open world markets. During the last fifty years the acreage under wheat has decreased from 3·5 to 1·5 million acres. It is probable that by more intensive manuring the production per acre of wheat might be increased from 10 to 20 per cent. On the other hand, the same expenditure on phosphates in certain areas of Australia where wheat is grown increases the production per acre by nearly 100 per cent. There is thus not the same hope for improvement in wheat growing in this country as there is in stock farming. The only means whereby the wheat farmer can hope to reduce his cost is by the introduction of machinery by which one man will be able to cultivate, or to reap and thresh 10 to 12 acres a day. With the exception of certain limited areas, however, our comparatively small British fields with their hedges and ditches are unsuitable for this form of extensive wheat growing.

Even suppose, however, we double our wheat crop, it would only mean another £10,000,000 to our agricultural revenue, whereas if we double our output of animal products it would mean another £200,000,000.

It is unnecessary to discuss here the relative merits of protection, subsidy, quota system or import boards. What the farmer needs is more money for what he sells, and the extra money must come either from the purchaser in the form of a rise in price or from the State in the form of a subsidy. If the State is to provide funds for the assistance of agriculture it would seem to be more advantageous to the nation to devote the money to the development of that part of the industry which is already either successful or on the verge of being successful, and is capable of great extension, than to wheat growing, which would need a very heavy subsidy or very drastic protection to make it profitable, and which even if doubled in extent would add only a few more millions to the agricultural revenue. A guaranteed price of 50*s*., or protection to maintain the price at that level, would cost the country something between £5,000,000 and £10,000,000, and even then it is doubtful whether the output of wheat would be doubled. That amount of money, however, spent on a subsidy or protection for bacon, eggs, dried milk, butter, cheese and beef, or even for some of these, would lead to very rapid developments. Half this sum spent on the protection and reorganisation of the pig industry would go far to enable us to produce at home the £40,000,000 of pig products which at present we are importing from foreign countries. A subsidy or tariff on dried milk, the consumption of which has increased by 400 per cent. during the last ten years, would go far to remove the disturbing effect of seasonal surplus production of milk.

When the Empire instead of the United Kingdom is taken as the unit, the position of wheat becomes even more difficult. The Empire produces more wheat than it consumes. As a whole it is therefore a seller and not a purchaser of wheat. No intervention by the State would be of value to the wheat producer unless it enabled him to sell his wheat in the United Kingdom at a higher price than in the open world market. But to raise the price of wheat in the United Kingdom above the world parity price would adversely affect stock farming. The least harmful method would be to give a subsidy. In that case, however, we would be paying from public funds for the increased production of an article of which there is already a surplus and which cannot be marketed profitably.

The case for animal products, on the other hand, is very different, because the Empire as a whole consumes more than it produces. The United Kingdom imports more than £100,000,000 of animal products from foreign countries. It is the only big market for these. We import more than half of what is exported from all countries in the world. Hence, any steps that would lead to increased production would be at least justified on the grounds that we have a home market to absorb the extra produce.

Another point of general importance to agricultural interests is that if the wholesale price of these products be raised, the whole benefit of the increased price would come to the industry, because they are end products; whereas wheat is to a large extent an intermediate product, part being sold from one branch of agriculture to another to be used as feeding-stuffs for stock. It is estimated that nearly half of the wheat grown in this country is used for feeding poultry. In view of the general position of agriculture, there is a good deal to be said for the policy of taking advantage of the present world surplus of wheat by developing intensive stock farming, which transforms this cheap material into high-priced animal products.

An attempt has been made to show that stock farming, which accounts for nearly three-fourths of the total agricultural revenue of this country, could be developed to a greater extent and by a smaller expenditure of State funds than the growing of wheat and other cereals for human consumption. There remains the question of employment. The branch of agriculture which gives most employment per unit area is market gardening, especially production of fruit and flowers under glass. In 1925, 2,725 acres under glass produced crops with a selling value of £4,800,000. Next to market gardening comes intensive stock farming, especially poultry, pigs and dairying. Five acres will give full employment to a man in either pigs or poultry. Thirty to forty acres will give employment to two people in dairy farming.[1] Further, pigs, poultry and dairy farming give regular employment all the year round. The employment in wheat growing, on the other hand, is much less per acre. It is difficult to get exact figures, because wheat growing is usually combined with other forms of arable farming or stock feeding for the better utilisation of labour. In any case it is only a seasonal occupation. With the introduction of machinery, which is now necessary for economical wheat growing, mechanics, taken on for a few days or weeks when required, will replace the agricultural labourer. Indeed this change is already taking place in the great wheat-growing areas in the world where the six or eight furrow plough and the combine harvester are eliminating the farm worker.

In conclusion it should be repeated that no attempt is made here to outline a policy of agriculture, nor is it suggested that the wheat grower has not a good case for at least temporary assistance in his present deplorable position. The present article is intended merely to show that whatever the policy be, the development of intensive stock farming should be its most prominent feature and that for the following reasons :—

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[1] It is not suggested that these are ideal units, or that holdings devoted exclusively to one class of stock are desirable. If agriculture could be reorganised, the units would be larger than at the present time, and they would be grouped round creameries and bacon factories to give each unit the benefit in buying and selling, and also to some extent in management, which is possible in big units. The figures are used merely to support the argument that this class of farming requires a large amount of labour per unit area.

(1) This branch of agriculture already accounts for three-fourths of the total agricultural revenue.

(2) It is at present on the whole either profitable or on the verge of being profitable, and therefore any assistance given by the State is likely to yield a big return in the form of increased production.

(3) The products of stock farming and market gardening have a special value in our markets because they can be marketed fresh.

(4) We have a home market which will absorb increased production to the extent of over £200,000,000 per annum, or taking the Empire as a whole, to the extent of over £100,000,000 per annum.

(5) The development of intensive stock farming must be accompanied by increased labour, which would be continuously employed all the year round.

AGRICULTURAL SURVEYS.

(Continued.)

In continuation of this series a summary is given below of the agricultural survey of two parishes in Ayrshire which was carried out in March and April of last year.

PARISH E.

This parish is situated on the Ayrshire coast, running inland for a distance of some three miles and rising steadily towards the east and north-east to about 200 feet above sea level. The land therefore slopes to the west and south-west, thus presenting a favourable aspect for agriculture. The agricultural area surveyed comprised about 3,000 acres.

Soil.—The soils vary from moderately heavy loams at the highest inland point to light sands on the coast. Between these extremes there are heavier sands, sandy loams and light loams. The nature of the soil largely determines the kind of farming practised, and it is possible to group the farms according to the system of farming in classes which correspond generally to the various soils. On the heavier loams dairy farming, with a winter sheep stock, is exclusively followed; on the light and sandy loams the system embraces dairying, cattle rearing and feeding, cropping (early potatoes included), with a winter stock of sheep; while on the light and heavy sands nearer the coast cropping (with a large proportion of early potatoes) and cattle feeding, with a summer sheep stock, are the main interests. These different classes of soils are common to extensive tracts of land in Ayrshire. The dairying land is similar to that of a large portion of North Ayrshire; the early potato land is characteristic of much of the coastal area; while inland from the latter are the easily worked light loams with a considerable admixture of blown sand.

"Soiltex" was used in an endeavour to estimate the area in the parish requiring liming. Practically every field was tested, the result being as follows:—

10 per cent. neutral.
17 per cent. slightly acid.
73 per cent. acid.

On the rotation and permanent grass land, however, there seemed to be no difficulty in establishing a sward of white clover. In some cases where the sole of wild white was outstanding the reaction was neutral. In others where the soles of both grass and clover were poor the reaction was exceptionally acid. The bulk of the land with a neutral or slightly acid reaction was in the light and sandy loam group, exclusive of the land under early potatoes. This was no doubt due to the fact that lime had been applied in recent years in the course of the rotation. For the most part the early potato lands were strongly acid. On the heavier loams no lime whatever had been applied for many years. Where lime had been applied on the light loams the good effect was very apparent. On the sandy loams the question is a more open one. Judged by the "Soiltex" test, lime did not appear to have a lasting effect on this kind of soil, but various examples were found where limed land had yielded crops heavier than the neighbouring unlimed land. An argument advanced against the use of lime where early potatoes are grown frequently is the difficulty of finding an opportunity for application when the lime would not have too much effect on the organic matter applied. Experiments carried out by the Agricultural College on similar soil in another part of the country show very striking results as a consequence of the application of lime. The yields of potatoes, turnips, oats and hay were greatly increased and grass land also showed much improvement. (Bulletin No. 118, West of Scotland Agricultural College.)

The reporters consider that there is room for a great deal of experiment on liming on these light soils, and also on the heavier loams found on the higher land. They also emphasise the need for development of the work on soils, both in the direction of survey work and in cropping and manurial experiments.

Holdings.—The holdings dealt with by the reporters number 33, of the following sizes:—

Size:	*1–30 acres.*	*30–50 acres.*	*75–100 acres.*	*100–300 acres.*	*Over 300 acres.*	*Total.*
No. of Holdings ...	16	1	5	9	2	33

The smaller holdings are situated chiefly on the light sandy land near the coast, in proximity to a small seaside town, and the holdings are utilised as grazing fields, market gardens, poultry farms and nurseries. The larger holdings are classified by the reporters into three main groups according to the system of farming followed, which is largely dependent, as indicated above, on the nature of the soil. These groups are shown in the following table, which also shows the range in rental of the holdings in each group.

GROUP.	Soil.	System of Farming.	No. of Holdings.	Range in Rental. per acre.
I.	Moderately heavy loam.	Dairying, winter stock of sheep.	7	20*s.* 4*d.*-35*s.*
II.	Light and sandy loam.	Dairying, rearing and fattening cattle, cropping (early potatoes included), winter stock of sheep.	4	45*s.* 9*d.*-49*s.* 6*d.*
III.	Sandy loam and light sand.	Cropping (with large proportion of early potatoes), fattening cattle, summer sheep stock.	3	47*s.* 10*d.*-57*s.* 4*d.*

There are minor differences in the system of farming as between the farms in a group, but generally the fundamental principles are the same within each group.

Of the 16 holdings over 75 acres in size 12 have been occupied by the present tenants or their forebears for over twenty years. Most of the larger holdings are let on leases of fourteen years' duration, only two farms being let from year to year.

Crops.—Of the agricultural land in the parish about 2,000 acres (or approximately two-thirds) are arable, the remainder being permanent grass land. Nearly half of the arable land is normally under rotation grasses, so that about two-thirds of the agricultural land is under grass.

The rotations vary considerably. On the Group I farms the rotation is a 7 to 10 course, normally as follows :—oats, mashlum or oats, first year's hay (seeded), second year's hay, grass 4 to 6 years. Only small quantities of roots are grown, and these are taken after lea or after stubble. In several cases the second hay crop is omitted, and often the first hay crop is cut green, without seeding. The taking of two white crops in succession would in most places be considered bad practice, and it seems rather extraordinary that no other system should have been evolved. Green cropping is not considered economic, as may well be the case on account of the cost of working the rather heavy soils, the difficulty in securing a successful braird and the risk of poaching the land.

On the light and moderately light loams of Group II the principal rotation is mashlum or oats, turnips, oats, hay, grass 2 to 5 years. Hay is omitted in some cases. On one farm on which there is a silo the rotation followed is silage crop, mashlum, oats, hay, grass 6 years. On the sandy loams of Group II and III the rotations used are numerous varying almost from field to field; in many cases no regular rotation is followed, the position being that with competent cultivation and manurial treatment much of this land will grow farm crops of almost any kind in most seasons. Examples of rotations are: (*a*) oats, hay or turnips, potatoes; (*b*) oats, potatoes, oats, hay or turnips; (*c*) oats, potatoes, wheat, turnips; (*d*) oats, potatoes. On some of the light sandy soils of Group III and part of Group II potatoes are grown year after year with in some cases an occasional wheat crop. On one field potatoes had been grown for 45 years in succession. Practically all the potatoes grown on farms in Groups II and III are early potatoes, and a catch crop of Italian ryegrass or rape is taken to be eaten by sheep.

Grain.—On the heavier land in the parish Potato and Victory oats are the commonest varieties both in the lea and on the sow-out crops of corn. Yielder is also frequently used in the sow-out, the straw being stiffer and tillering to a lesser extent. Seeding on both lea and stubble for Potato oat is about 5 bushels, for Victory and Yielder 5 bushels after lea and 6 bushels in the second corn crop. The seed is usually procured from the east or north of Scotland and is changed in a few cases every year, but generally every second or third year. The typical manurial treatment is the application of 2 to 3 cwt. of a compound manure containing 8 per cent nitrogen, 19 per cent. phosphates and 3 per cent. potash. This applies both to lea and stubble oats, though for the latter an application of from 2 to 4 cwt. dissolved bones is occasionally substituted. Yields varied from 35 to 55 bushels in the case of the lea oats and 25 to 45 bushels for stubble oats.

On the lighter lands in the parish Yielder is the most popular oat, but Record, Victory, Beseler and Marvellous (winter sown) are also grown. The seeding varies from 5½ to 6½ bushels for all these varieties except Marvellous, which is sown at the rate of 7 bushels. The lower rates apply mainly to drilled-in oats and the higher to broadcast. The manurial treatment is very varied. After potatoes artificials are not usually applied; elsewhere compound manures are used. Yields varying from 50 to 100 bushels were estimated by the farmers, with an average of about 70 bushels.

Only about 30 acres of wheat are grown in the parish. It is all winter sown, and the yield of grain is estimated at 45 bushels. Part of the straw is used on potato pits and part for thatching.

Potatoes.—On the lower farms (Groups II and III) the potato crop is a very important one and is almost entirely composed of the one variety, Epicure. There are from 900 to 1,000 acres suitable for early potato growing, and the annual acreage planted is from 360 to 400 acres. The crop is planted in March and the harvesting does not begin usually till mid July, and the bulk, being lifted in August, is therefore not in time to catch the earliest market. The potatoes are later in this parish than in some other districts of Ayrshire, because late spring frosts are apt to occur owing to the configuration of the ground. The rainfall is moderately heavy, from 36 to 38 inches per annum, which, together with a high water table, ensures a fairly adequate supply of water for the intensive cultivation practised on these light sands and sandy loams. The supply of organic matter is maintained by large applications of farmyard manure. Additional organic manure comes from the catch crops of Italian ryegrass taken after potatoes and eaten on the ground by sheep. Farmyard manure is applied " on the flat " at rates varying from 10 to 20 tons per acre, the heavier applications being given on the lighter soils. Artificial manuring consists usually of a mixture of sulphate of ammonia, superphosphate of lime, potash salts and bone flour or guano, the two last being added to the mixture as dryers. The dressing varies from 11 to 14 cwt., manurial ingredients in the mixture amounting to about 8 per cent. nitrogen, 19 per cent. phosphates and 3 per cent. potash. The weight of seed potatoes required per acre varies from 1 to 1½ tons according to the size. Crop yields were estimated at from 10 to 15 tons.

Roots.—From 80 to 90 acres of turnips, practically all swedes, are usually grown in the parish, seeding being at the rate of 4 lb. per acre. The typical artificial manurial treatment is a mixture containing about 3 per cent. nitrogen, 28 per cent. phosphates and 3 per cent. potash, applied on farms in Group I at 5 to 8 cwt. per acre and on the lower farms at 10 cwt. per acre. On the Group I farms a dressing of 10 to 15 tons of farmyard manure is applied in the drill, and in the Group II and III farms similar quantities on the flat. The yield estimated for Group I is 20 to 25 tons, and in the other groups 25 to 30 tons.

On the lower farms some mangolds are grown for late feed.

Mashlum and Silage.—For mashlum the seeding is normally 6 bushels per acre, in several cases equal quantities of oats and beans being sown, but generally there is a larger proportion of oats. A mixture of artificial manures containing about 2 per cent. nitrogen, 23 per cent. phosphates and 9 per cent. potash is applied at 1½ to 3 cwt. per acre. The threshed product was estimated by various farmers at from 20 to 30 cwt. Silage is grown on one farm in Group II, the crop being sown after the lea. The mixture consists of 3 bushels oats, 2½ bushels beans, one-half bushel peas, and one-fifth bushel vetches. About 20 tons per acre is the normal yield.

Grass.—On the heavy loam farms of Group I the rotation grass soles in several cases were poor. Farmyard manure is applied on the first year hay at rates varying from 4 to 8 tons per acre and again when available at lesser rates where hay is cut in the second year. Dressings of sulphate of ammonia or of compound manures are also applied to the hay crops. The reporters consider that much of this land would benefit greatly from a more extended use of basic slag; where it has been applied the improvement was most marked. In one or two cases too much ryegrass was included in the seed mixture. On the farms in Groups II and III the rotation grass soles in most cases were satisfactory, good seed mixtures being used and manurial treatment being sound. Where hay was seeded the yield in 1929 was estimated at 6 to 8 cwt., and the price realised varied from £15 to £17 per ton.

Permanent grass in the parish is moderately good, but there can be no doubt that a wider use of slag and other fertilisers would effect great improvement.

Stock.—*Dairy Cattle.*—There are 13 dairy herds in the parish, the sizes of the herds being as follows :—

No. of Cows:	*Under 10.*	*10–20.*	*20–30.*	*30–40.*	*40–50.*	*50–80.*	*Over 80.*
No. of Herds	1	3	4	2	1	1	1

The cows are practically all of the Ayrshire breed, 58 per cent. being pedigreed. With the exception of one or two Shorthorn and one Galloway, the bulls used are mainly Ayrshire,

Cows are calved regularly throughout the year in order to maintain as regular a supply of milk as possible. On all the purely dairying farms in Group I most of the cows are bred and reared on the farm, and unless disposed of for faults, &c. reach an age of 10 to 12 years, and in exceptional cases 14 years, before being cast. In none of the herds are the cows regularly tested for tuberculosis. Milk records are kept for three herds, representing 37 per cent. of the total number of dairy cows.

On four farms the cows are rationed strictly according to yield, on six the heavier yielding cows are given more than the lighter yielding cows, while on three farms no attempt is made to ration according to yield.

Owing to the several methods of milk disposal, viz. :—retail selling, sales to town dairies, butter making and calf feeding, and to the small proportion of herds which are milk recorded, the reporters found it difficult to obtain reliable data in regard to milk yields. The following is regarded as a rough indication of the position in the herds :—

Average milk yield per cow.	*Under 500 gallons.*	*500–600 gallons.*	*600–700 gallons.*	*Over 700 gallons.*
Percentage of herds	10 %	10 %	50 %	30 %

The difference in average milk yield per cow between the higher and the lower yielding herds is very considerable, and it is clear that there is marked room for improvement.

Beef Cattle.—This class of cattle is both home-reared and bought in. The bought-in stores are generally Irish or local, the majority being of an excellent type.

Sheep.—There are eight ewe stocks on holdings in the parish, one being pedigreed. The following indicates the numbers of flocks in each breed and the tups used :—

4 Border Leicester × Leicester.
1 Half-bred × Suffolk.
1 Greyface × Leicester.
2 Blackface × Leicester.

The farms in Groups I and II carry a winter stock of sheep which are usually put on in October and sold off about April or May.

In almost all cases the sheep receive hand feeding, but, if not, they are on good low ground grazing. The ration generally consists of 1 to 1½ lb. of mixtures containing such concentrates as oats, bean cake and dried grains. Turnips may or may not be given in addition to this ration. Blackface ewe stocks receive a ration of bruised oats for about six weeks before lambing. Average lambing percentages estimated by farmers are as follows:—Border Leicester 170 per cent.; Half-bred 150 per cent.; Greyface 150 per cent.; Blackface 120 per cent.

The sheep stocks appeared to be fairly healthy. Braxy had occurred in one or two cases and a serum had been used. Liver fluke was troublesome on one holding and Danistol had been given.

Poultry.—Since 1922 the number of fowls on holdings in the parish has increased by 100 per cent., the number being about 7,000. Small numbers of ducks and turkeys are also kept. The reporters consider that on some farms more attention could profitably be paid to this department.

Five of the small holdings, 1 to 5 acres, are devoted almost entirely to poultry keeping. The stocks range from 140 to 850 in number. The most favoured breeds are White and Black Leghorns, Light Sussex, Rhode Island Red and White Wyandotte. The usual practice is to sell all the old birds in September or October and keep only the young stock. The young birds which start to lay in October are kept for one laying season. In most cases trap nesting is done for three months each year, November to January.. Sales include eggs, which are either retailed or sold to local grocers, table fowls, day-old chicks and eggs for hatching. The feeding is divided into a grain ration and a wet mash. The grain ration usually consists of wheat, kibbled maize and oats.

In some cases laying birds get ground maize, *ad lib.*, about an hour before roosting. The mash is fed at the rate of from 1 to 2 oz. per bird and usually consists of bran, middlings, maize meal, Sussex ground oats and fish or meat and bone meals.

Pigs.—Very few pigs are kept in the parish, there being at the time of the survey only 19 feeders on 16 holdings. They were Large White or Large and Middle White crosses.

Labour.—The wages of the three principal classes of workers in the parish as at Whitsunday 1929 were as follows:—

	Weekly Cash Wage.		*Estimated Weekly Value of Perquisites.*		*Total.*	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*
Ploughmen (married)	35	0	4	2	39	2
„ (single)	18	6	14	0	32	6
Cattlemen (married)	40	0	7	8	47	8

The length of day worked is from nine to ten hours, with generally a half holiday on Saturday. At the potato lifting time there is a large influx of workers, many of them Irish, these invariably being provided by the potato merchant purchasing the crop. The class of labour in the parish is good and employers are well satisfied. In a number of cases it was found that workers had been on the same farm for many years.

Drainage.—On the whole, drainage in the parish is satisfactory, the areas on which draining and repair of old drains is required being confined almost entirely to the heavier loams. The areas requiring attention extend to some 200 acres or about 8 per cent. of the total area.

Buildings and Equipment. — The farm houses are all substantial buildings in a good state of repair, though certain conveniences were lacking in a number of them. The cottages were in a fair state of repair, the larger sized houses tending to be in a better condition than the smaller ones. On the whole the situation of the steadings as regards the working of the farm is good, but in a few cases conditions are cramped and extensions desirable. Apart from a few minor alterations required to improve ventilation the byres were of a high standard. All the farms appeared to be adequately equipped with cultural implements suitable for the system followed. With regard to fences, 70 per cent. could be classified as in first class condition, 20 per cent. as moderately good and 10 per cent. as poor.

Marketing.—Except in the case of a proportion of the milk, the marketing of produce is done individually. Sixty per cent. of the dairy farms were selling their milk through the Scottish Milk Agency, the other 40 per cent. retailing their milk in the neighbouring towns. Eggs and a certain amount of butter are sold either to grocers or retailed locally. Cattle and sheep are sold in a neighbouring market town, stores also being purchased there. Early potatoes are sold by the acre to potato merchants either by auction or privately. Prices obtained in 1929 ranged from £34 to £40 per acre. Apart from the Scottish Milk Agency there is no evidence of any co-operative effort either for purchasing agricultural requirements or disposing of produce. The close proximity to good markets naturally affects progress in this direction.

Agricultural Education. —Only a few of the farmers in the area had come in contact with the extension work of the Agricultural College, although a fair number take an interest in the results of any College experiments published in the agricultural and local papers. On one farm the holder, in consultation with the County Organiser, is experimenting in the manuring of early potatoes, and is also testing various grass seed mixtures. There appeared to be room for experimental and educational work in the district.

Farm Economics and Financial Results. —While the number of holdings included in the survey is too small to permit of reliable generalisations, the following table compiled by the reporters is of interest. The farms are grouped as shown in the paragraph relating to Holdings.

GROUP.	Capital.		Wages per acre.		Manures purchased per acre.	Feeding stuffs purchased per animal unit.†	Gross Sales.	
	Per acre.	Per labour unit.*	Total acreage.	Arable acreage.			Per acre.	Per labour unit.*
	£ s.	£	£ s.	£ s.	£ s. d.	£ s.	£ s.	£
I.	10 15	372	1 19	2 16	0 9 2	3 7	10 0	346
II.	20 3	516	3 7	3 16	1 18 6	4 7	21 10	547
III.	19 17	650	2 11	4 2	3 8 6	6 0	23 3	787

* One man employed for a full year taken as the labour unit.

† Live stock units calculated as follows:—

1 cow, bull, steer, horse = 1 unit.
2 calves, heifers, colts = 1 ,,
7 sheep or 14 lambs = 1 ,,
5 hogs, 10 pigs = 1 unit.
100 head of poultry = 1 ,,

Some interesting comparisons are made by the reporters. For instance, it was found that the capital per acre varied in roughly the same ratio as the proportion of land under crops, the comparative figures being as follows :—

GROUP.	Proportion of farms under crops (including hay and timothy, but excluding rotation and permanent pasture).	Capital per acre.
	per cent.	£ s.
I.	36	10 15
II.	61	20 3
III.	55	19 17

The figures for manures per acre show a rapid increase from Group I to Group III, probably mainly due to an increasing intensity of cultivation, with an increasing proportion of the farms under early potatoes.

With regard to financial results, farming in the parish did not appear to be suffering from severe depression such as is to be found in some parts of the country. There is no doubt, however, that the financial returns in certain departments were being adversely affected by those factors which were contributing towards agricultural depression generally. Mixed farms where dairy herds were kept, cattle reared and fattened, early potatoes cultivated and sheep feeding practised, appeared on the whole to be fairly prosperous. The purely dairy farms on the heavier land were more varied as to financial results. Some were providing a bare living while others were doing rather better. In both groups the retailing of milk by the farmer added considerably to the farm profits. The farms on which cattle feeding (without rearing) and cropping (including large areas of early potatoes) form the mainstay did not appear to be doing as well as the mixed farms with dairies, taking into consideration their size, quality of land and capital invested. The reporters came to the conclusion that in recent years on these farms cattle fattening had been little more than paying its way; corn growing for sale had been unprofitable; early potato growing had been profitable so far; and the sheep stock had left a profit, though of course this is a comparatively small item in the farm economy.

Conclusions.—While farming in the parish was not suffering from such severe depression as is reported from other areas, the adverse effect of poor prices in certain departments was being felt. The management and methods of most of the farms compared favourably with those of similar farms in other districts. The main suggestions for improvement put forward by the reporters may be summarised as follows :—

1. On the heavier land there was room for improvement in grass land management. Temporary and permanent grass would benefit greatly by the more extended use of slag and of well balanced grass seed mixtures, and it is suggested that useful educational work could be done in this direction.

2. While the rotation followed on the heavy loam farms (two white crops in succession and no cleaning green crop) is an old established one in the parish and in other parts of Ayrshire, it is suggested that experiment might show that it is not the only possible economic system, in the district surveyed at any rate; that, for instance, with suitable treatment of the soil, turnips might be grown, or silage crops could be introduced to be stored in silos modified to suit the size of the farms and the available capital.

3. The subject of liming requires urgent consideration. Lime could be used more extensively with advantage on most of the farms. The heavier land would, without doubt, benefit greatly, but the objection was raised that it was uneconomic to apply it at present prices. The advisability of applying lime to the light potato lands is a more open question, but the weight of evidence in the district seemed to favour the practice; further research and experiment on this question are necessary, and quality as well as quantity in potato crops should be given consideration in this connection. There is room for extended soil investigations, accompanied by cropping and manurial experiments.

4. The milk yields on a number of the farms showed much room for improvement, and it is suggested that production could be increased with advantage, or savings effected, if more attention were paid to (*a*) milk recording, (*b*) the selection of bulls from good milking strains, and (*c*) the feeding of balanced rations according to yield.

5. Poultry keeping is increasing in importance as a depart-

ment of the farming business in the district and it might with profit be further developed. There are still too many farms where poultry receive scant attention and cannot possibly be paying.

PARISH F.

This parish is situated in the north-east corner of Ayrshire and was selected mainly as being typical of the higher lying dairying districts in the county. The general aspect is towards the south-west, the land rising more or less gradually from about 350 to 930 feet. The area surveyed extends to over 14,000 acres. The dairy farms, with which the report is chiefly concerned, are devoted entirely to the production of winter and summer milk for sale as liquid milk.

Soil.—In the northern half of the parish the soil is peaty, the land being for the most part moorland and rough hill grazing, devoted almost entirely to sheep. The soil in the remainder of the parish ranges from moderately heavy to heavy loam, being typical of extensive tracts of land in Ayrshire, and is almost exclusively devoted to dairy farming.

The "Soiltex" test, where made, showed that the soils of the arable and grass land were strongly acid, this condition being evident also from the appearance of the herbage, and there is no doubt that the land would benefit considerably from a fairly heavy application of lime. Not only would this result in an increase of the productivity and stock carrying capacity of the holdings, but an improvement would doubtless be effected in the health of the stock. Although there are indications that more attention is now being paid to the subject, and that more lime is being applied than formerly, the reporters state that, in view of the present prices of lime, there is little hope of more than a fraction of the area being limed each year. The reporters consider that the question of soil acidity and lime requirement in relation to plant growth requires further investigation.

Holdings.—The number of holdings included in the survey was 69, the sizes being as follows :—

Size :	*1–30 acres.*	*30–50 acres.*	*50–100 acres.*	*100–150 acres.*	*150–300 acres.*	*Over 300 acres.*	*Total.*
No. of Holdings	15	6	17	16	13	2	69

In classifying the holdings according to size rough grazing land was not taken into account. Of the 21 holdings under 50 acres, 14 were in grass, one was occupied by a tomato grower, and only six were cultivated, four of these being sheep farms each with a large extent of grazing land and two being dairy farms; ten of the 21 holdings were occupied by persons who were not deriving their living from the holdings.

The report deals more particularly with the 48 holdings over 50 acres and the four sheep and two dairy farms classified as under 50 acres, a total of 54 holdings. On 41 of these holdings there are dairy herds. Fourteen farms carry a breeding stock of sheep under hill conditions and six a stock under arable or pasture conditions. On a few farms cattle are reared for sale as back-calving queys and on eight farms sheep—usually ewe hoggs—are wintered. Practically the whole products sold off the farms are live stock and live stock products. The rentals for the dairying holdings range from 17*s*. to 22*s*. on the higher lying farms and in general from 26*s*. 6*d*. to 31*s*. on the lower farms.

Crops.—The arable land of the parish occupies 20 per cent. of the total area, permanent grass 32 per cent. and rough grazings 44 per cent.

As explained more fully below in connection with the management of dairy stock, the dairying practice in the parish has changed in comparatively recent years from the production of a summer supply of milk (much of which was made into butter and cheese) to the production of an all-the-year-round supply of milk for sale as such. It would be reasonable to suppose that the general farming practices would have been modified to suit the altered conditions, but this is not so; and in view of the soil altitude and climate it does not seem possible to adapt properly the farming practice, although no doubt slight modifications could be made with a view to the home production of more winter fodder and feeding stuffs.

The main object of cropping is the removal of pasture and, as would be expected in such a high lying district where a considerable proportion of the land is on the fringe of moorland, the cultivated area is reduced to a minimum. In many cases no regular rotation is followed, but the practice is to take one oat crop and sow grass seeds along with it, hay being cut for one or more years and the pasture grazed for 10 to 15 years thereafter. On a few of the more purely sheep farms rape is substituted for oats. On other holdings the rotation is oats, oats, hay, hay, and pasture for a number of years. Where a root crop is grown it takes the place of a portion of the second oat crop and is followed by sown-out oats. Considering that there is in many cases no cleaning crop and that in others the area is small, the land is fairly free from serious perennial weeds. It was stated repeatedly by farmers that the growing of turnips is hazardous and that in a wet season, owing to the nature of the soil and the high rainfall, "poaching" occurs, with the result that the following pasture is adversely affected for a complete rotation and that the growth of rashes is stimulated. Very little lime has been applied for many years and, provided the land is adequately drained, it is reasonable to suppose that the application of lime would be beneficial.

Oats.—During the last few years the area under oats has been about 900 acres. The average yield for the parish in 1929 was 44 bushels per acre, though the yield for stubble oat crop would probably range from 25 to 35 bushels. The oats are practically all fed to stock.

Roots.—The annual area under turnips is only about 100 acres, principally in the lower lying farms. The treatment is fairly normal, artificial manures being applied. The yield for 1929 was estimated at 12 tons per acre. A few potatoes are grown for home use.

Hay.—This is the most important crop in the parish, the area being on an average not far short of 2,000 acres, of which about 700 consist of rotation grass cut for hay. As everything is done in the way of manurial treatment to obtain a bulky crop of meadow hay, practically all the farmyard manure is applied to the meadow land. What little may be left over is applied to the rotation grass which it is intended to cut a second year for hay. A dressing of sulphate of ammonia is also usually given to the meadow land, and where facilities exist liquid manure is applied. Meadows are allowed to lie for many years, being ploughed up only when they have ceased to produce a useful crop. Some of the meadows in the parish have been down for 30 years and over. It was observed that in many cases the hay produced contained a considerable proportion of the natural grasses which will have a lowering effect on the feeding value of the crop, and the reporters suggest that investigation might be made into the composition of some of the older meadows and the feeding value of the hay produced.

The estimated average yield for rotation grass hay in 1929 was 26 cwt. per acre, and 46 cwt. per acre for meadow hay.

Large proportions of ryegrass, 1 to 2 bushels, with a few pounds of cocksfoot or timothy, form the bulk of the typical grass seed mixtures. The number of farmers sowing up-to-date mixtures suitable for long leys and likely to produce good grazing for stock is disappointingly low. The following is an analysis of the mixtures sown on 34 representative holdings :—

Sowing 1 to 2 bushels of ryegrass in mixture ...	27
Not sowing any of the clovers	11
Not sowing any wild white clover	16

Of these 34, only seven were sowing suitable mixtures, four being proprietary mixtures.

Grassland.—Pasture is of the utmost importance as it is relied on to provide practically the whole of the summer food for stock. In too many cases, however, great attention is paid to the hay crop at the expense of the subsequent pasture, but when it is realised that the land is normally in grass for ten or more years and that therefore the establishment of a good pasture is of much more importance than the rotation hay crop, it is a matter for some surprise that so little attention has been paid to the subject in the past. As indicated above many of the mixtures are not satisfactory from the point of view of the establishment of good grazing, in many cases no clovers being sown. The reason for the exclusion of clover was sometimes stated to be that clovers had been tried but had not been a success, but with the application of lime and suitable artificial manuring there would seem to be no reason why clover should not grow well. Where suitable treatment has been given, wild white clover has responded readily in the district. In some cases no artificial manures or only those not required for the cropped land are applied to the pastures. While it would appear that more attention is now being paid to the subject the reporters express the view that there is ample scope for improvement.

The reporters also found that large areas of the older grassland were under rashes and other areas were reverting to a natural state.

Rough Grazings.—Nearly half of the area of the parish consists of moorland or rough hill grazings situated for the most part at from 150 to 900 feet above sea level, and mainly utilised for the grazing of sheep. About 70 per cent. of the hill grazings consists of black land or peat, heather being found on 15 per cent. of this area. The grazings contain an ample supply of draw-moss, which provides a succulent spring food, but there is a shortage of good heather. The bulk of the green land, particularly the parts formerly cultivated, is overgrown with rashes or " spruit-grass."

Stock.—*Dairy Cattle.*—There are 41 dairy herds in the parish, the sizes of the herds being as follows :—

No. of Cows :	*1–20.*	*20–30.*	*30–40.*	*40–50.*	*Over 50.*	*Total.*
No. of Herds	8	16	11	4	2	41

Except in one case where a Friesian bull is used, the herds are all of the Ayrshire breed. Only six herds, or 15 per cent., are milk recorded. Only one herd produces Grade A (T.T.) milk and one herd is registered in the Herd Book.

Prior to 1906 or a few years earlier the dairy farms were all organised to produce a summer supply of milk, which was largely converted into butter and cheese. The management of the herds was in most cases somewhat similar to the present methods on cheese-making farms in the south-west of Scotland. The cows were carried over the winter " dry " on a maintenance ration and calved in the early spring to supply milk during the summer months when the cows were at grass. The quantity of milk produced in the winter was small in proportion to the quantity produced in the summer. The amount of purchased feeding stuffs required was therefore a minimum, and the cost of production per gallon was consequently low. The system of producing summer milk under natural conditions at a relatively low cost has been supplanted by the production of an all the year round supply at a much increased cost. The change was gradual, and it was probably not until about 1923, when the 20 per cent. surplus clause was introduced into milk contracts, that the proportion of winter milk increased so much. Under this clause a lower price was paid during the summer months for milk in excess of average monthly winter production, based on three winter months, plus 20 per cent.

As already indicated, however, no more winter fodder or feeding stuffs are produced on the farms than formerly, so that the whole additional nutriment required for the production of winter milk is supplied in the form of purchased feeding stuffs. Hay is the principal home-produced winter food. Of the higher lying farms only a few have turnips available. Oats are fed chiefly to the young stock. The winter feeding, therefore, consists of hay and purchased feeding stuffs. There is an entire absence in most cases of succulent food, and there is little doubt that the health of the stock suffers in consequence, particularly where there is any faulty feeding of concentrates, which the presence of a succulent or more bulky food might tend to counteract. Most of the farmers stated that the cows were rationed very roughly according to yield, although in one or two instances more careful rationing was done. On about half of the farms the cows received no concentrates for about two or three months while at grass, and on the remainder a small ration is given during the summer months.

Abortion is the most serious disease which affects the stock, and practically all the herds appear to have had serious infestation at some time or other during recent years, the percentage of cows affected in one or two instances being as high as 95 per cent. of the herd. The proportion of cows cast for various reasons such as weeds, faulty udders, digestive or feeding troubles, injuries, low milk yield, &c., also appears to be unduly high.

On 19 holdings in regard to which accurate figures were available, the quantity of milk sold per cow in 1929 varied from just over 500 gallons to over 800 gallons, the income from the sale of milk varied from £25 per cow to over £50 per cow, while the cost of feeding stuffs purchased per cow varied from £10 to £19 (the figures in each case being the average for the herd). In these 19 cases all the milk was disposed of except that required for rearing calves and for domestic purposes, and as in every case the proportion of calves reared in each herd was approximately the same, the number of gallons disposed of per cow may be regarded as indicative of the relative milk yields. The wide variations indicate that there is considerable room for improvement of the milk yield in some cases.

Sheep.—On 13 farms a regular stock of Blackface ewes is carried, ewe hoggs being kept for stock in ten cases and gimmers or hoggs being bought in in three cases, this being necessary as the ewes are crossed with a Border Leicester tup and no pure Blackface lambs are available for stock. On five farms a flying stock of Blackface ewes is carried, cast ewes being bought in each year and generally only one crop of lambs being taken. On eight of the farms carrying a regular stock of ewes, the ewe hoggs are wintered away from home on lower ground, generally from 1st October until 1st April, at a cost of about £14 per score.

The lambing percentage amongst the Blackface stocks is usually from 90 per cent. to 95 per cent., while with Blackface ×

Border Leicester stocks on low ground, where feeding is adopted the average percentage is about 100 per cent. to 110 per cent.

Fluke has been troublesome on the wetter green land parts of the rough grazings, but more farmers are now using carbon tetrachloride with excellent results. Trembling has also caused losses, amounting in certain seasons from 1 per cent. to 2 per cent. The loss from drowning on the moorland grazings, however, is much more serious than the total losses from disease, the number of ewes drowned being about 4 per cent. to 5 per cent.

Pigs.—In the area surveyed there were only 28 breeding sows.

Poultry.—Since 1921 the number of fowls in the parish has practically doubled, the figures for turkeys although comparatively small also showing a considerable increase. It is quite clear that most of the farmers are finding that poultry, properly managed, contribute very considerably to the farm revenue, and in many cases the poultry stocks are being greatly increased. Eight holdings, six under 8 acres in extent, and two between 50 and 100 acres, were devoted almost entirely to poultry keeping. The most favoured breeds are White, Black and Exchequer Leghorns, White Wyandotte, Rhode Island Red and Light Sussex, and in one case sex-linked crosses are raised. In most cases the hens or a proportion of them are kept for two years in order to obtain eggs for hatching; but in some cases they are kept for only one laying season. The general tendency now in the parish is to dispose of the hens at an earlier age. On some holdings it is the practice to buy in Irish pullets each year to maintain the numbers. The feeding consists of a grain ration and a mash. The grain ration usually consists of wheat, maize and oats, and the mash is either a proprietary mixture or made up on the premises, such foods as bran, middlings, maize meal and fish meal being used.

Labour.—The holdings are mainly worked by the occupiers and their families. The number of married men employed is extremely small, the labour consisting mainly of single men and lads who reside in the farmhouse, usually in a room above the milk house or boiler house, and receive full board. On some holdings a girl is employed. Casual labour is required for hay and harvest, a proportion being Irish, although there are rather fewer Irishmen employed than formerly. The reporters express the view that if farm cottages were available more married men could be employed, with advantage to the farmers, and a larger population could thus be supported on the land.

Drainage.—Compared with other parts of the country the parish has responded well to the Government Drainage Schemes, but even so the reporters bring out the fact that the work of drainage is not keeping pace with ordinary wear and tear. Of the arable and pasture land 440 acres have been drained since 1918, an average of less than 40 acres per year, or only 0·6 per cent. of the total area. The reporters consider, however, that at least four times this amount of drainage would be required each year in order to deal with ordinary renewals and deterioration, without any leeway being made up. Under present conditions, however, they do not think that any great increase can be expected in the area drained each year. It was estimated that 30 per cent. of the arable and pasture land and 57 per cent. of the rough grazings require draining.

Buildings and Equipment.—The farm houses are all substantial buildings in a good state of repair, but very few have a bathroom, hot water circulation or modern sanitary conveniences. There were no cottages occupied by workers on the holdings surveyed. On the whole the situation and accommodation of the steadings are satisfactory. Of the 66 byres in the parish, eight now conform to the requirements of the Milk and Dairies Act. Of the others, two require to be reconstructed, while in most cases the alterations required are chiefly roof and stall ventilation, lighting, and the abolition of direct communication between dwelling-house and milk house and the byre. All the farms appeared to have an adequate equipment of cultural implements. The fences, hedges and dykes were generally in fair order with the exception of the march fences on some of the hill farms, which were in a poor state of repair.

Marketing and Co-operation.—Except in the case of milk the marketing is done individually, and there is no co-operation in the purchase of feeding stuffs, manures, &c.

At the time of the survey 80 per cent. of the farmers were co-operating in the sale of milk mainly through local creameries. Milk is received by the creameries from the farmers twice daily during the summer six months and once daily during the winter six months, and is pasteurised on receipt at the creamery. During the winter months the evening milk is cooled on the farms. Most of the milk is despatched to Glasgow in the evening, there being a small delivery in the morning. About 8 per cent. of the milk handled by the creameries is made into cheese, some butter also being made at one of the creameries. Milk delivered to or collected by the creameries is paid for on the basis of the percentage of butter fat. Samples are drawn daily and tested periodically. The average butter fat percentage of all milk supplied during the month is taken as the basic figure and an allowance of 0·2 per cent. above or below is made. A slight increase or deduction in price is made for every 0·2 per cent. variation. The prices paid to the farmers for milk are generally about 2½*d.* per gallon less than the prices received for milk sold, the difference being necessary to cover the lower price received for milk manufactured, haulage charges to Glasgow and working expenses of the creamery.

Eggs are mainly collected by or delivered to grocers or retailers in Glasgow or neighbouring towns. Generally eggs are not graded, although the small ones are usually sold separately. In view of the importance of the poultry industry in the parish, there appears to be ample scope for an egg grading and marketing organisation either in conjunction with the existing co-operative societies or as a separate organisation.

Agricultural Education.—The reporters comment favourably on the work which is being carried out by the West of Scotland Agricultural College in the parish and surrounding districts. This takes the form of lectures on such subjects as grass land improvement, dairy cow feeding, handling of milk, poultry keeping, &c.; practical demonstrations and experiments in regard to manurial treatment, crop cultivation, &c.; and the organisation of clean milk competitions, of which there were nine in the county of Ayr during 1930.

Financial Results.—The reporters consider that during the past few years the dairy farms have generally either given a fair financial return or at least enabled the farmer to make ends meet where the holding is reasonably well managed. The price of milk during the winter of 1929 was, however, almost 3*d.* per gallon or about 20 per cent. less than during the previous winter, and should there be a prolonged spell of lower prices the financial position will be materially altered, unless a relative decrease in the price of feeding stuffs occurs. Sheep generally had given a reasonable return except where the size of the flocks was too small to be economic in regard to labour. Poultry appeared to be yielding a good return, and in fact several farmers, with a stock of 300 to 400 hens and 20 to 25 dairy cows, stated that of the two departments the former had recently been the more profitable.

Conclusions.—The reporters were able to obtain a great deal of interesting and valuable information, which it is not possible to refer to in detail, in regard to other aspects of the agriculture of the parish, but their main conclusions may be summarised as follows :—

1. Wide variations in efficiency and production exist between the holdings surveyed. From a financial point of view dairy farmers were generally suffering no loss, but a continued fall in the price of milk would alter the position. Sheep were normally giving a satisfactory return. Poultry keeping was a profitable department, the number of poultry being almost doubled since 1921.

2. The parish is almost entirely devoted to dairying, and has changed over from the production of summer milk to an all the year round supply. The cost of producing winter milk is the main problem and the economics of this require careful investigation. Very little cropping is done and the tendency is to reduce the cultivated area still further. More winter food could with advantage be produced on the farms in the form of silage, forage crops, &c.

3. There has been a decline in the number of dairy herds which are milk recorded.

4. Notwithstanding the creation by the State of small holdings, any increase in the number of holdings which should thereby be effected is being negatived by the process of amalgamation which is going on elsewhere in the district.

5. An area, equivalent to 10 per cent. of the present arable and pasture land, which was formerly cultivated, has now reverted or is in process of reverting to a natural state and is classified as rough grazings.

6. Thirty per cent. of the arable and pasture land requires draining, and in spite of the drainage which is being done normal deterioration is not being made good. Without increased State aid there appears to be little prospect of any improvement in the situation.

7. Practically all the arable and pasture land is in need of lime; the whole question of soil acidity, however, requires further investigation.

8. There is room for improvement in the laying down and management of both temporary and permanent grass land.

9. The provision of more shelter belts in the parish is desirable.

10. Eighty per cent. of the farmers co-operate in the sale of milk. Conditions are suitable for the co-operative grading and marketing of eggs.

11. As has already been stated in connection with the survey of other parishes, it appeared to be quite clearly the case that despite the number of factors outwith the holders' control the efficiency of the individual is the determining factor in successful husbandry.

THE BIOLOGIST on the FARM.—No. XL.

Sir J. Arthur Thomson, M.A., LL.D.,

Emeritus Professor of Natural History, University of Aberdeen.

The Wintering Snail.—In late autumn snails become more than usually sluggish and seek out winter quarters. This is an instance of a vital rhythm, for it is exhibited at the proper time even by snails that are kept in the artificial summer of a greenhouse. One of the characteristics of life is enregistration. In obedience to a constitutional prompting the snail creeps into shelter under moss and withered leaves or in the loose ground at the foot of an old wall, and there, using the front part of its creeping " foot " or muscular ventral surface, it excavates a rounded hole in the ground in which it ensconces itself.

Retracting its head and foot, it secretes from the glandular margin of its skin-fold or " mantle " (which makes the shell) a winter-lid or epiphragm. This consists partly of mucus, which hardens into a membrane, and partly of lime, both carbonate and phosphate. If one looks very carefully at the lid, one can find, in the big Roman snail at least, a little chink, through which gaseous exchange with the atmosphere is kept up during the winter retreat. There is no doubt that the lid is protective, for if it is injured the snail dies when exposed to very keen frost, whereas the animal can survive a night's exposure below zero if the lid is quite intact. Having finished the lid, the snail draws itself still more forcibly into the shell, and secretes a number of thin membranes, one after the other. They have their use too, for the air between the papery sheets acts as a non-conductor and conserves the little there is of the precious animal heat.

The word hibernation should be kept for those few mammals, like hedgehog and dormouse, which pass into the strange physiological state known as "winter-sleep." All that one can say of the wintering snail is that it reduces its vital functions to a minimum and lies low saying nothing. Of course it takes no food, but in a sense it may be said to be living on its liver! For it absorbs the stores of animal starch or glycogen which were accumulated in days of plenty. All the snail needs for about six months in the year is a little oxygen, which seeps in through the chink in the winter-lid. That suffices to keep the fire of life burning; or, to put it less metaphorically, the slow combustion of the animal-starch reserves in the liver supplies energy enough to keep the heart beating. In the big edible snail the heart beats on an average about four or five times a minute during the winter rest, a great contrast to the summer rate, which is about ten or twelve, and may rise to much more in midsummer. The wintering snail has learned the difficult lesson that a reduction of income should be met by a reduction of expenditure. If the experimenter breaks the winter-lid and washes the shell in warmish water, the snail may be induced to show itself in midwinter; but it soon falls "asleep" again, and its resisting power is seriously lessened by the interruption. There is much to be learned from the wintering snail.

The spreading of the Grey Squirrel.—It seems very short-sighted to allow this interesting and beautiful, but dangerous alien to increase in Britain as it is now doing. It seems to have been known for a century, but it did not become common till within recent years. Since 1889 there have been 33 introductions, and according to Mr. A. D. Middleton's recent study, it is now widespread. At Burnham Beeches over 4,000 have been shot in the last ten years, and still they come. Our reason for alarm is simply that the squirrel is very destructive to trees, and that it is a sorry business to plant forests for these aliens to devour. The squirrel works definitely against tree-planting, which is in many ways so desirable. One species of squirrel is quite enough for a small country like ours, and to allow another one to get the upper hand seems to us to be extreme foolishness. As Professor James Ritchie says in his great book, *The Influence of Man on Animal Life in Scotland* (1920), "the spread of the Grey Squirrel threatens us with a plague as grievous as that which rewarded the well-meant efforts of the enthusiasts who set the Common Red Squirrel free in our woods, that his interesting presence might add to the delights of Nature lovers." He quotes the verdict of Sir Frederick Treves that the Grey

Squirrels "eat everything that can be eaten and destroy twenty times more than they eat."

The records of the past suggest, we think, that squirrels are more readily checked than some other rodents, such as rats, voles and rabbits. For it seems certain that the destruction of forests in Scotland, terribly accelerated by the iron-smelters of the sixteenth, seventeenth and eighteenth centuries, led to a practical, if not total, extermination of the Red Squirrel, so that it became by 1775 or earlier a great rarity, only known in the depths of remote forests like those of Rothiemurchus. But soon after its practical or total disappearance the Red Squirrel began to be re-introduced, and this reinstatement has been a success from the æsthetic and pure Natural History point of view, but a disaster economically. And now, slow to learn, we are introducing another species!

Very interesting to the biologist is the question of the relation between the newcomer and the native Red Squirrel, a question parallel to that between the Black Rat, our older alien, dating from the Crusades, and the Brown Rat, that did not reach Britain till about 1728. But it is not easy to answer these questions, especially, perhaps, the question about the two squirrels. Some observers have seen combats between the two kinds, and have jumped to the conclusion that the newcomer is directly ousting the native species. But there is little evidence to warrant this generalisation. In some cases the two species live amicably in the same wood; and since the century began there has been in some areas, still unoccupied by the Grey Squirrel, a marked decrease of the other. Mr. Middleton advises suspended judgment until more facts are gathered, but he seems disinclined to accept the popular view that the Grey Squirrel directly expels the Red Squirrel. He points out that our native species likes coniferous woods and feeds largely on seeds, bark, buds and fungi, whereas the Grey Squirrel likes open mixed woods, spends much time on the ground (though active enough on the tree tops, as many of us have seen in Scotland), and is almost omnivorous. Not only does it bark trees and eat off leading shoots, it devours bulbs and buds, fruit and vegetables, and like the Red Squirrel it is not averse to the eggs and nestlings of birds—especially of small birds who cannot defend themselves. Our conclusion is that one squirrel is enough.

Specificity of Pig's Blood.—The Biologist on the Farm has often used this difficult word "specificity" and explained it; but it is so indispensable that he may tell once again what it means. Every well-defined kind (or species) of living creature is itself and no other. There is an individuality in every kind of organism which marks it off from its nearest relatives. Sometimes it has a chemical basis, as Gautier showed long ago for the different varieties of grapes. It is probable that every "good species," really deserving a name to itself, has a particular protein of its own. Even the red pigment of the blood differs in nearly related mammals, though it is always "hæmoglobin." When it is made to form crystals, these may be microscopically distinguishable, even in mammals so near one another as fox and dog, or horse and donkey. Sometimes the specificity or individuality is expressed in minute differences of structure, thus the cells lining the windpipe of a sheep are different from those in a similar position in a dog, though it must be admitted at once that the resemblances are much greater than the differences. It is because of specificity that some zoologists can sometimes identify a passing bird from a single feather dropped from its plumage, or a fish from a single scale. Fingerprints are notorious instances of more than specificity, namely individuality, but we shall not go into that.

The case that we last came across concerned pig's blood, and that has surely to do with the farm! Kiyotsuna Sasaki and Kurashi Moribe have recently shown that it is possible to distinguish the blood of the wild boar from that of the domestic pig by the differences in their (precipitin) reactions. We do not explain the delicate "serological" methods used, for these are beyond our present scope; we are simply concerned with the general biological fact that it is possible by blood-tests to distinguish nearly related animals. The "serological" method has been used successfully in distinguishing domestic Japanese duck and the wild form, and goldfishes from crucians. It also holds for rabbit and hare, but these cannot be said to be very closely related.

The pigs used were the Berkshire breed and the Japanese Wild Boar. The Berkshire pig is usually regarded as an improved derivative of a mixed type derived from *Sus scrofa* and *Sus vittatus*. The Wild Boar of Japan is the white-moustached variety, *Sus vittatus japonicus*. So these nearly related forms illustrate specificity in their blood!

Genetics of the Horse.—There are many very interesting facts in a scholarly paper by Professor F. A. E. Crew and Mr. A. D. Buchanan Smith, published in the 1930 volume of *Bibliographica Genetica*. The authors (assisted by Miss Cytovich) have brought together, in very compact form, many important data, and give a list of useful references to the scattered literature. We venture, with compliments to the authors, to select a few of the interesting data.

(*a*) Julius Cæsar rode on a two-toed horse (commemorated for a time by a statue in Rome), and there have been several records of various degrees of polydactylism or "cloven hoof." Thus digits II and IV may both be well represented by much more than the little "buttons" at the ends of the splints or metapodials (II and IV). It will be remembered that Professor Cossar Ewart showed embryologically that these "buttons" were vestiges of the missing digits II and IV. The authors note that, according to Boas, polydactylism may be due to atavism (i.e. to a rehabilitation or reactivation of long dormant ancestral primordia, dating from the three-toed horses of the distant past), or to duplication, i.e. to some unexplained tendency to lay down a double foundation for some developing structure. Might there not be a third kind of polydactylism, of a modificational not variational, nature, through the mechanical pressure of amniotic strands or the like on the developing limb-bud? This kind of polydactylism would not be hereditarily continued, while the variational type is.

(*b*) Reduction in size in the course of generations is often the result of exposure to unfavourable environmental conditions. The larger and more modern types are eliminated, being presumably less resistant. Thus on the desolate Sable Island, Nova Scotia, to which horses were twice imported (in 1760 and earlier), there arose (by 1860) six herds of wild ponies. "In about 150 years the horses had returned to the habits of the wild tarpan, which they resembled in size, hairy heads and thick coats." There was a survival of reversionary types—an instance of the toughness of dwarfs. The males among the Sable Island ponies were very fierce and seemed to sleep standing.

(*c*) People are always willing to discuss *de novo* the fertility of mules, the charm of the subject probably being as an exercise in criticising "downright facts." Our authors do not wobble. "However rarely it may happen that a mare mule may become a parent, this undoubtedly does take place occasionally." The sire may be a donkey or a pony. It is reported from the Texas College of Agriculture that a foal of a mare mule by a stallion "has proved himself the sire of at least five foals, all of which are normal and horse-like." But this is surely an almost unique record, the general verdict being that male mules are completely sterile. The need for sceptical scrutiny of the evidence may be illustrated by a remark made by Crew and Smith: "It is known that unmated female mules may secrete milk, and it is not improbable that many of the cases in which mules have been reported as having been fertile are nothing more than instances of such an animal having adopted a foal." A mule in the stricter sense is the result of a cross between a male ass (a "jack") and a mare; very little seems to be known about the hinny—the result of a cross between a stallion and a female ass or "jennet" ("jenny"). For some unknown reason there seems to be a high percentage of unfertility among jennies.

Caddis-Worms.—In the mud of ponds—if the water is not foul—and under the stones in the shallows of slow-flowing streams, and even in the ditches, one finds during the wintry months many resting caddis-worms, which become a little more conspicuous later on when they take to roaming about in search of food. They are the larvæ of the rather beautiful, but not very familiar, caddis-flies, dull-coloured insects somewhat like little moths, with many hairs on their wings. Hence they are called *Trichoptera,* which means "hairy winged"; and some entomologists call them *Phryganeidæ.* They are often regarded as near relatives of the most primitive moths. As adults they do not seem to do much in the way of eating; the mandibles, as in moths, are mere vestiges or altogether absent. We are not aware that caddis-flies do any harm; they may be seen resting on plants or flying feebly near the water.

In the summer months the female caddis-flies lay their eggs in gelatinous clumps or ribbons, which sink to the floor of the pool or are moored to water plants. After a while there emerge the somewhat caterpillar-like larvæ, firmly built in front, but very delicate behind. So they proceed to cover themselves with little pieces of stick and stone, or leaf and bark, by which their real nature is quite camouflaged. They have a high standard of workmanship, fastening the selected materials by means of delicate threads of silk, and usually forming a tubular case. Through the larger anterior opening they protrude their strong head and legs, while the soft posterior body is fastened by a couple of hooks to near the narrower hind end of the case. It is not easy without breakage to pull the larva out from in front, for it takes a strong grip; but anglers, who sometimes use big ones for bait, have learned to prod them out from behind by inserting the head of a pin or something of that sort. The larvæ are unwilling to leave their case, which not only affords protection and concealment, but is sometimes of use in keeping them weighted down and thus less likely to be washed away by a current. If we carefully open one of the tubes we may see delicate breathing threads on each side of the body; the animal's movements inside its tube keep up a respiratory current. If we take some home to study—in a soup-plate with some water-weed and debris—we must give them a drip from the tap, for few of them can survive stagnancy. They are mainly vegetarian, nibbling at water-plants and also getting some sustenance from microscopic Algæ. In captivity some of them may be induced to attack little fragments of raw flesh, and there are some very interesting kinds, with one British representative, which make beautiful nets of silk, fastened with the mouths pointing up-stream. These net-weaving caddis-worms differ from the ordinary ones in being sedentary, not rovers, and in being carnivorous, not vegetarian. The device of making a net is a good instance of that instinctive inventiveness in face of which we may well stand amazed!

If anyone with a little spare time wishes to engage in an experimental study of animals readily available about the farm, we can recommend caddis-worms. They do not cost anything for their keep, and they are not always dying! It would be interesting and scientifically profitable to continue the experiments of Miall, Lutz and others in regard to the case-making habits. As a rule a particular kind of caddis-larva keeps to a particular kind of building material—pebbles, pieces of stick, fragments of leaf, fine particles of mud, minute snail shells, and so on. Several build fine grains of sand into spiral shells which were regarded for a while as new species of snail! Many years ago Professor Miall made the neat experiment of disrobing some caddis-worms and putting them in an aquarium where platelets of mica were the only materials available for building a new case. The larvæ used these transparent platelets, and the naturalist was able to study their breathing movements through the glassy walls of the tube. Dr. Frank E. Lutz of the American Museum has recently made similar experiments, and has seen the disrobed larvæ making new cases out of sea-urchin spines and out of pieces of Bladderwort. There is considerable plasticity, and an interesting point is that some individuals are more willing to adapt themselves than are others of the same kind.

The caddis-worms are resting just now. When spring comes they become active again—feeding, growing and moulting. When they are full-grown they become pupæ within their closed-up cases, and undergo their great change or metamorphosis. About midsummer the pupa emerges from its case, rises to the surface, pulls itself on to a plant, and undergoes a final moult—disclosing the winged adult. So we have ended where we began.

Linnets and Dandelions.—As the Biologist on the Farm has kept very close to his job in this article, he may be allowed to end up (for the time being, *bien entendu*) with a little canter on one of his hobby-horses—the study of inter-relations in the Web of Life. What is the connection between linnets and dandelions? The question has been recently asked and answered by Dr. Joseph Grinnell, one of the Professors of Zoology in the University of California. The dandelion is a very beautiful and interesting plant, but it is a weed on the lawn; and though it fills the grass with stars, its presence is regarded by the householder with great disfavour. To Professor Grinnell's discerning eye, however, it became evident that it is an ill wind that brings nobody good. The wind that blew in the dandelion down also brought the Californian linnets or house-finches, which are among the most cheerful songsters of that part of the world. And how does the wind bring the linnets? Simply because these birds are particularly fond of dandelion down. Early in the spring morning, the male linnets come out of their shelter among the untrimmed vines on some of the older walls, and pour forth their song from the wood-shingles of the roofs. About seven in the morning as the sunshine first sweeps the weedy lawn, the linnets descend and seek out the heads of the dandelions. Each female is closely attended by a jealous male; each pair keeps to itself in a different part of the lawn; all are after the down before it sets sail. We quote Grinnell's summary, for it illustrates one of the central facts of Biology, that nothing lives or dies to itself: "Oldish houses with untrimmed vines about them; rather informal, therefore carefree, householders; lawns with dandelions in them; then linnets; and *therefore*, mornings and evenings, the neighbourhood pervaded by the most heartening of Californian bird songs." We are not, of course, recommending the cultivation of weeds—we must not be woodenly serious about such matters—we are simply giving a picturesque instance of inter-relations, and reminding ourselves and our readers that if every rose has its thorn, even weeds may make for music.

IDENTIFICATION OF POTATO VARIETIES BY CHEMICAL TESTS.

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The accurate identification of the different varieties of potatoes is a problem which has become increasingly important in recent years. Under the regulations of the Department of Agriculture for Scotland and the Ministry of Agriculture, varieties of potatoes which are sold for seed purposes must reach a certain standard of purity (97 per cent.), and the growing crops designed for seed are inspected annually for this purpose; the acreage inspected in Scotland amounted to 59,802 in 1929 and to 43,287 in 1930.

During the summer months the identification of the different varieties, while requiring careful training and experience on the part of the inspector, does not present any serious difficulties, such characteristics of growth as nature of haulm, colour of flower, shape of leaf, &c. being relied on.

When the crops have been harvested, however, the identification of a variety from the appearance and shape of the tubers is often a matter of much difficulty; in this case, the identification is arrived at by the examination and comparison of the shape of the tuber, depth of eye, colour of skin and colour of flesh; some of these features, however, are not characteristic in many cases of any one variety and may also show considerable variation in the same variety. Tubers can be classified into groups by reference to their sprout characters, e.g. colour, distribution of colour, shape, pubescence, rapidity of development, &c. This has been the most useful method in the past of separating varieties during the storage season, but it is slow, as in the winter months sprout formation is difficult to induce, and even in the spring several weeks are necessary for the development of these characters. Useful information can be obtained by subjecting the tuber to a laboratory test for "wart disease" (*Synchytrium endobioticum* (*Schilb*), Percival), by which means the varieties can be divided into classes; the other tests indicated above can then be applied. The time required to carry out this test in winter, even under favourable conditions, is considerable and requires a special and rather laborious technique.

Chemical Tests.—It has long been known that chemical differences exist between the different potato varieties, especially as regards their composition. During the war an extensive study of the chemical composition of potato tubers was undertaken by a Committee of the Royal Society (*Royal Society Food (War) Committee*, 1919 : *Report on the Composition of Potatoes grown in the United Kingdom*).

The dry matter and total nitrogen content of several varieties from a number of widely separated sources were determined, and it was shown that the locality in which the plants were grown had an important influence on the composition of the tubers.

The work of other British, Continental and American investigators showed that the composition of the tubers was affected more by the place and conditions of growth than by varietal differences, the general result being that the fluctuations in the amounts of total nitrogen, starch and dry matter, due to environment, render their determination unreliable for the discrimination of varieties; in any case, the estimation of the nitrogen, starch and dry matter is too laborious to be of any use for the rapid identification of varieties.

Various other methods were investigated; it was found, for example, that the starch grains differed in various respects, e.g. mean diameter, content of phosphoric acid, iodine absorption, &c., but no method suitable for rapid routine work could be founded on these differences.

It has long been known that potatoes contain small quantities of very active chemical substances known as enzymes, many of which, particularly the oxidising enzymes, give typical colour reactions, and it seemed probable that the investigation of these colour reactions with various reagents might give useful results.

In a paper published in this Journal (XI, 1928, 304), T. P. M'Intosh describes some preliminary work on these lines; he gives the results obtained by the use of several reagents, viz. potassium hydroxide, benzidine, para-cresol and nicotine; the results obtained were so important that a more detailed examination of the method seemed desirable; a grant was therefore made by the Department of Agriculture for Scotland and the Development Commissioners to one of us for a further investigation; the results obtained are described in the following paper.

The first step was to repeat M'Intosh's work and to select from the reagents he had tried one or more which appeared to be worth more detailed investigation; the results obtained by him were confirmed, and it appeared that the most suitable test for a detailed investigation was the para-cresol reaction with tyrosinase, one of the oxidising enzymes present in potatoes; this test can be very easily applied, and the uniformity and nature of the colour made the reaction highly suitable for the present investigation.

For the preliminary investigation a dilute aqueous solution (0·2 per cent.) of p.-cresol was used; thin slices of the potato tuber were treated with the reagent, and an orange red colour, which in most cases was uniform throughout the section,

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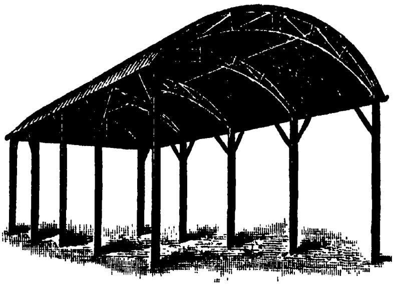

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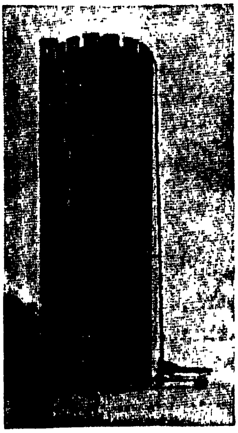

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appeared in about 5 to 10 minutes; the results obtained are given in Table I.

TABLE I.

Dark Red.	Intermediate.	Light Orange.
Bishop.	Abundance.	Arran Victory.
British Queen.	Ally.	Dunottar Castle.
Crusader.	Arran Comrade.	Eclipse.
Edzell Blue.	Arran Chief.	Kerr's Pink.
Golden Wonder.	Epicure.	King Edward.
Immune Ashleaf.	Great Scot.	
Katie Glover.	Harbinger.	
King George.	Rhoderic Dhu.	
Majestic.	Tinwald Perfection.	
President.	Up-to-date.	

These results are very similar to those obtained by M'Intosh.

For more accurate work a more exact method of judging the colour had to be devised; the orange-red tint produced was therefore analysed and found to be composed of red and yellow in the ratio of 2 to 1 approximately. A tintometer was then constructed by which the intensity of the colour produced on a tuber was compared with a colour standard and given a definite numerical value.

The details of the reaction were carefully studied and a standard " technique " for carrying out the test devised. After numerous experiments with various solvents, it was found that a solution of para-cresol in dilute sodium hydroxide gave the most rapid and consistent results; it was also found that the temperature affected the rate of the reaction, and so the temperature was controlled by means of an electric hot-plate, the measurements being made at a uniform temperature of 18° C.

A section of about 0·75 cm. (about ⅜ inch) was cut parallel to the long axis of the potato, treated with 2 or 3 drops of the reagent and allowed to drain on filter paper for 30 seconds. The stained section was then placed in the tintometer and the colour matched with the standard colour glasses.

The effect of various factors on the reaction were then studied in detail, e.g. (*a*) maturity, (*b*) environment, (*c*) disease, &c., (*d*) season, and (*e*) storage.

(a) *Maturity.*—In order to examine the effect of maturity upon the reaction, it was arranged to follow the growth of a number of plants throughout the summer of 1929. For this purpose six well-known varieties were chosen, namely :—Duke of York, Epicure, Great Scot, Golden Wonder, Majestic and Ally. These varieties differ widely in time of maturing, Duke of York and Epicure being in the " first early " class, Great Scot, Majestic and Ally in the " early maincrop," and Golden Wonder in the " late maincrop " groups. The potatoes were grown in Midlothian at seven different localities referred to as A., B., C., within a radius of about six miles. At an early stage of growth healthy and characteristic plants from each variety were selected and marked for examination; the following table gives the varieties marked at the different centres :—

TABLE II.

Duke of York.	Epicure.	Great Scot.	Golden Wonder.	Majestic.	Ally.
A.	A.	A.	A.	A.	A.
B.	...	B.	...	...	...
C.	C.	C.	C.	C.	C.
D.	D.	D.	D.	D.	D.
..	E.	...	...	...	E.
F.	...	...	...	F.	...
...	G.	G.	...	...	...

A. = College Garden, Liberton, Edinburgh. (2½ miles S.)
B. = College Farm, Boghall, Midlothian. (5½ miles S.)
C. = Seed Testing Station, Dept. of Agriculture for Scotland. (5 miles W.)
D. = Messrs. Dobbie & Co., Joppa. (4 miles E.)
E. = J. R. Gray, Esq., Southfield, Duddingston. (2½ miles E.)
F. = R. J. M. Brockley, Esq., Gorebridge. (10 miles S. E.)
G. = R. L. Scarlett, Esq., Inveresk. (6½ miles E.)

At intervals up to complete ripening a few tubers were taken from each plant. The samples were taken to the laboratory as quickly as possible, where they were weighed, treated with the standard para-cresol reagent, and the colour measured as already described; each variety was sampled about five times, the dates of sampling ranging from 20th June to 5th October.

An examination of the data indicated that the activity of the potato tyrosinase varied with the age of the tuber, being greatest at the early stages of growth and diminishing gradually as the plant matured; at the same stage of maturity the size of the tuber had no influence on the enzyme activity. For any one variety the activity is constant when the tubers are mature; this indicates the importance, when carrying out the test, of using only mature tubers.

An example of the kind of results obtained is given in Table III; the variety examined was Duke of York : K is the velocity constant (i.e. the rate of the development of the red colour with time), and r_{10} is the value of the red colour after 10 minutes.

TABLE III.

Date of Sampling.	Weight of Tuber in grams.	K.	r_{10}
25. 7.29	146	1·7	14·3
	62	1·7	13·4
4. 9.29	126	1·5	11·8
	27	1·5	12·1
.7.10.29	250	1·4	12·4
	103	1·4	12·2

(b) *Environment.*—It has already been pointed out that the percentage of dry matter, nitrogen and starch of the tubers of a particular potato variety vary with the situation where the variety is grown. In order to see how far environment influenced the tyrosinase para-cresol reaction of mature tubers, experiments were arranged whereby potato plants were grown in soils of various types in widely separated localities and at various altitudes, as well as in soils of varying degrees of acidity. Mature tubers were obtained from the plants grown at the seven centres in Midlothian, already described in the section dealing with maturity. The soils varied from light garden soils at A. and D. to clay loams at B. and C. The manurial treatment was similar in each case, about 20 to 25 tons of farmyard manure and from 8 to 10 cwt. per acre of a mixed mineral fertiliser being applied. The plots at B. received special treatment to produce a wider range of acidity and will be dealt with separately. The localities B. and F. were over 500 feet and the remainder between 100 and 200 feet above sea level.

When the plants were ripe, typical tubers were selected and a sample of the soil was taken from beneath each plant. The soils were air-dried in the laboratory and the acidity determined, the results being expressed on the pH scale. In this way it was possible to compare the reactivity of the tyrosinase to the para-cresol reagent in any one variety in plants grown at different altitudes, in different types of soil, and in soils of varying acidity.

TABLE IV.

Effect of Environment.

Locality.	Altitude. O.D.	Soil Type.	Soil Acidity (pH units).	Duke of York.		Epicure.		Great Scot.		Golden Wonder.		Majestic.		Ally.	
	feet.			K.	r_{10}	K.	r_{10}	K.	r_{10}	K.	r_{10}	K.	r_{10}	K	r_{10}
A.	200	Garden.	6·9	1·4	12·4	1·5	12·1	0·98	8·1	1·4	14·4	1·3	12·2	1·4	12·0
B.	600	Clay Loam.	5·5	1·5	12·8	...	...	0·98	8·5	...	...	...	...	...	...
C.	200	Do.	4·9	1·5	12·2	1·5	12·3	1·0	8·3	1·5	14·1	1·3	12·0	1·5	12·4
D.	100	Garden.	5·4	1·5	13·3	1·5	12·4	0·99	7·8	1·5	14·5	1·3	12·5	1·4	12·3
E.	100	Medium Loam.	6·4	...	...	1·4	11·8	...	...	...	...	...	...	1·4	12·6
F.	500	Clay Loam.	5·3	1·5	12·9	...	...	...	...	...	...	1·4	12·5	...	...
G.	100	Sandy Loam.	7·3	...	...	1·4	12·1	1·0	8·6	...	...	...	...	...	...

The acidity is represented on the "pH scale," where 7 indicates neutrality; figures lower than this indicate acidity and above 7 alkalinity.

It will be seen from the results that within a limited area neither the type of soil nor the altitude has any appreciable effect on the reaction. At locality B. (College Farm, Boghall, Midlothian) five plots each 1/200 acre were marked off and specially treated to produce a wide range in soil acidity. Two of the plots were treated with " flowers of sulphur " which is oxidised in the soil to sulphuric acid. A third plot was untreated, while the remaining two were made alkaline by treatment with calcium hydroxide (slaked lime). The plots were treated about the end of March, a month before the potatoes were planted. The varieties grown were Duke of York and Great Scot.

TABLE V.

Effect of Soil Acidity.

Plot.	Treatment (per acre).	Soil Acidity (pH units).	Duke of York.		Great Scot.	
			K.	r_{10}	K.	r_{10}
A.	10 tons Slaked Lime.	8·1	1·5	12·8	0·96	8·3
B.	3½ " " "	7·5	1·5	13·1	0·96	8·2
C.	Untreated	5·5	1·5	12·5	0·98	8·5
D.	800 lb. Sulphur.	5·1	1·5	12·6	0·97	8·3
E.	1,200 " "	5·0	1·5	12 9	0·96	8·5

It is seen from the table that, even under the extreme ranges of acidity and alkalinity experimented with, no effect on the reaction was produced. It is worth noting that the tubers grown in the acid soils had very clean skins and were most attractive in appearance in contrast to those grown in the limed soils, which were invariably dirty and unhealthy-looking.

Tubers were also obtained from a wide variety of districts in Scotland (Aberdeenshire, Banffshire, Perthshire, Fife, Midlothian, Ayrshire and Dumfriesshire), and the results indicate that the influence of the locality on the reaction was, in general, negligible.

(c) *Disease, &c.*—Ordinary commercial stock frequently contains tubers affected by the common diseases, injured during lifting, or " greened " through exposure to light. The reaction was found to be affected by all these conditions, sometimes to a serious extent. The diseases investigated were " Common Scab " (*Actinomyces scabies* (Thaxt), Güssow); " Corky Scab " (*Spongospora subterranea*, Lagerh); " Blight " (*Phytophthora infestans* (Mont), De By); " Blackleg " (*Bacillus atrosepticus*, van Hall); " Sprain " (*Bacterium rubefaciens*). It was thought that the effect of some virus diseases (e.g. Leaf roll or Mosaic) on the reaction might form the basis of a method for the detection of these diseases in their early stages when they are unrecognisable by an examination of the tuber. The results showed, however, that the milder forms of the disease had little effect on the course of the reaction.

The reaction cannot therefore be applied to (*a*) diseased stock; (*b*) damaged stock; (*c*) tubers which have been greened by exposure to light.

(d) *Season.*—The seasons of 1928 and 1929 differed widely and afforded a good test of the effect of season on the reaction. The season 1929 was very favourable for potato growth and a large crop of healthy well-formed tubers was obtained, the yield being well above the average; 1928 was much less favourable and a lighter crop resulted. Samples were obtained in both years from the following counties:—Aberdeen, Perth, Midlothian, Ayr and Dumfries, and subjected to examination; the results showed that there was little or no seasonal variation even in the strongly contrasted seasons referred to.

(e) *Storage.*—Considerable variation occurs in the conditions under which the potatoes are stored, and it was necessary to investigate the effects, if any, of these variations on the reaction. The methods in use depend on whether the variety is early or late, on the nature of the season, accommodation, &c. The following varieties were selected for the experiment:—Duke of York, Epicure, Great Scot, Golden Wonder, Majestic and Ally. Samples of these were stored in three different ways:—(*a*) in a pit; (*b*) in bags in a cool well-ventilated storehouse; and (*c*) in a refrigerator, the temperature of which was kept at 2° C. The three sets of samples were stored in the autumn of 1929 and examined in the spring of 1930; it was found that if the tubers were kept for a day at room temperature before the test was applied the reaction had not been affected to any appreciable extent.

Application of the Reaction to the Discrimination of Varieties.—The conditions which affected the reaction having been determined, the next step was to see how the reaction could be used for distinguishing potato varieties. Before applying the test the varieties were divided into five groups according to their colour, &c. The results of the test are given in the following table, the figures indicating the red component of the colour as measured in the tintometer; " b " is the average value of the results from all the tubers examined of any one variety, while the figures "a" and " c " indicate the lowest and highest readings possible; the figure " a " was obtained by subtracting three times the standard error of experiment from the lowest average value actually found; in the same way " c " was calculated by adding three times the standard error to the highest average value. It can be taken as certain, therefore, that the value for any one variety will always fall between the limits of " a " and " c."

TABLE VI.

White Varieties.

Variety.	*a*	*b*	*c*	*Variety.*	*a*	*b*	*c*
Dunottar Castle ...	1·0	2·5	4·0	**Witchhill**	8·0	9·5	11·0
Eclipse	4·0	5·5	7·0	**Rhoderick Dhu** ...	8·0	9·8	12·0
May Queen	4·5	6·0	7·5	**Arran Chief**	8·0	10·2	13·0
Great Scot	7·0	8·5	9·8	**Arran Comrade** ...	8·8	10·5	12·2
Up-to-Date	5·8	8·5	12·3	**Lochar**...	9·0	10·5	12·0
Royal Kidney... ...	8·0	9·5	11·0	**Epicure**	10·5	12·0	13·5

Variety.	*a*	*b*	*c*	*Variety.*	*a*	*b*	*c*
Ally	11·0	12·5	14·0	Immune Ashleaf ...	12·6	14·3	16·0
Majestic	11·0	12·5	14·0	Champion	13·0	14·5	16·0
Duke of York... ...	11·2	12·8	14·3	Golden Wonder ...	13·0	14·5	16·0
Tinwald Perfection ...	11·5	12·8	14·3	Crusader	15·0	16·5	18·0
Abundance	11·5	13·0	14·5	President	15·5	16·5	18·0

Pink Varieties.

Kerr's Pink	4·5	6·0	7·5	Gregor Cups	13·5	15·0	16·5
Reading Russet ...	7·5	9·0	10·5	Sharpe's Pink Seedling	17·5	19·0	20·5
Rogue like Great Scot	8·5	10·0	11·5	Raeburn's Gregor Cups	19·5	21·0	22·5
Orange Anther Substitute	9·5	11·0	12·5				

Blue Varieties.

Arran Victory ...	7·5	9·0	10·5	Edzell Blue	15·5	17·0	18·5

White Varieties with Pink Eyes.

King Edward... ...	3·5	4·5	6·0	Katie Glover	16·0	17·5	19·0
K. of K.	5·5	7·0	8·5				

White Varieties with Purple Eyes.

Catriona	11·0	12·5	14·0	Di Vernon	15·0	17·5	19·5

Applying the above results to the separation of varieties, it will be seen that it is possible to separate two varieties when the value of " c " for one is equal to or less than the value of " a " for the other. For example, Great Scot having a value of " c " equal to 9·8 units can be distinguished with certainty from Ally, which has a value for " a " of 11·0 units. Great Scot, however, cannot be separated with confidence by this method from Arran Comrade, which has a value for " a " of 8·8 units, and cannot be distinguished from Royal Kidney for which " a " is 8 units. Kerr's Pink can be distinguished without difficulty from any of the other pink varieties with which it is so often confused. Similarly, Arran Victory can be separated from Edzell Blue and King Edward from Katie Glover; ordinarily, such separations can be made only by observation of the growing plants.

British Queen and King George gave very irregular colouring when treated with the reagent and have, in the meantime, been omitted from the table. Three other varieties—Arran Chief, Up-to-Date and Di Vernon—did not give concordant results. These varieties are very susceptible to leaf diseases such as mosaic and leaf roll, and the first two are also susceptible to wart disease infection. With regard to Di Vernon, it appears that a number of types are at present included under this name and it may be that more than one variety exists.

It should be clearly pointed out that the method is not suitable at present for the identification of single tubers, and that the method is a comparative rather than an absolute one. The ordinary case which occurs in practice is to distinguish between two varieties, the name of one of them, and, in many cases, the names of both being known; under such circumstances the method can be applied with success. The method can also be used to determine the percentage purity of a sample when it is known that the only rogues present belong to varieties whose range of reaction differs significantly from that of the variety in question.

Other Methods of Investigation.—In addition to the p.-cresol reaction, various other methods were investigated in the hope that they might be of use for identifying varieties either alone or in conjunction with the p.-cresol reaction. The acidity of the sap of the tuber was investigated very carefully, and while the results are of high scientific interest in dealing with a fundamental question in plant physiology, they were unfortunately of no use for the purpose required. In the same way the phenolic and amino substances present in minute amounts in potato tubers were also investigated, and the results suggest that further study will yield additional means of discrimination. The reactions of the pectic substances present in potatoes gave a method of distinguishing between Great Scot and Arran Chief, which are difficult to separate by other means.

We have to express our indebtedness to the Department of Agriculture for Scotland and to the Development Commission for the grant which enabled this investigation to be made. We desire also to thank very cordially the following for help and advice in procuring material and for granting us facilities for experimental work:—Dr. T. P. M'Intosh and Mr. Thomas Anderson, Department of Agriculture for Scotland; Mr. W. M. Findlay, Aberdeen College Farm, Craibstone; Mr. A. S. B. Wilson, College Farm, Boghall; Dr. A. M. Smith, Edinburgh; Mr. J. S. Chisholm and Mr. George M. Stuart of the Horticultural Department of the College; Messrs. Dobbie & Co., Edinburgh; Mr. R. L. Scarlett, Inveresk; Mr. J. Mitchell, East Craigs; Mr. R. S. M. Brockley, Edinburgh, and Mr. J. R. Gray, Portobello.

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NOTE.—*The Experimental work described in this paper was carried out by Dr. Robertson.*

THE MOST PROFITABLE WEIGHT FOR MARKETING PIGS.

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Introduction.—In comparing pig-keeping in Denmark and in Great Britain one of the points on which most observers lay very considerable stress is that in the former country only two breeds are kept as compared with the dozen or so which are still officially recognised in this country. In support of these different

British breeds it is claimed that the alternative markets for pork and bacon necessitate their continuance, whereas in Scandinavia no corresponding problem exists. The market for bacon pigs is, within certain well understood fluctuations, a constant one. On the other hand the pork market at times offers, or appears to offer, exceptionally tempting profits, though it is well understood that this market is extremely erratic. Whether to cater for one or the other or to attempt to supply both according to circumstances is therefore a matter of policy which has to be decided by every producer. Much has been written in text books and journals on this subject, but the main lines of argument fall into two groups. In the first place experimental results, mainly American, are cited to show that the heavier the pig becomes, the greater is the amount of food required to produce a gain in weight. In conjunction with this the prices of pork carcases are shown to be higher than those for bacon pigs of greater weight. On the other hand, it is claimed firstly, that the high overhead cost of the weaner added to the actual food consumed makes the total cost per lb. much higher at the lower live weights, and secondly, that the figures for food consumed represent live weight, while those for sales represent dead weight, and that the carcase-dressing percentage increases rapidly as the pig reaches heavier weights. So far, however, no detailed figures have been available in this country from which a proper interpretation could be deduced. This matter has therefore been examined afresh in the light of figures made available as the result of an investigation by the Duthie Experimental Stock Farm and the Cambridge Animal Nutrition Institute into the best method of making available the most recent scientific information on pig-keeping. The full results of this investigation will shortly be published elsewhere, but the present communication summarises the situation as it concerns the costs at different weights.

Cost of Live Weight Gains.—The essential data on which the conclusions are based are the costs of producing an average pig from the previous weaning of its dam up to a weight of 270 lb. live weight, and Table I shows the comparative costs per unit of gain for each period of the pig's life. For the purposes of this paper only the total costs have been included, and the results from three successive farrowings have been averaged in the final figure instead of being given separately in detail. From columns 2 and 8 in this table it will be seen that the amount of food required at the heavier weights is exaggerated by expressing it, as is usually done, in terms of meal required per 1 lb. of live weight gain *during* each period (col. 2). When the figure *from weaning* to the end of each period (col. 8) is taken, the relative increase in food required is considerably less.

Again it should be observed that while food costs form by far the greatest single item in the cost of producing a fat pig, the incidence of this cost varies considerably at different weights. Reference to columns 9 and 11 will show that while the amount

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Comparative Costs per Unit of Gain.

PERIOD.	Cost per 1 lb. gain.												Line Nos.
	During each period. Food per 1 lb. live weight.	To end of each period.											
		From sow's previous weaning.					From pig's weaning.						
		Live weight.			Dead weight.		Live weight.				Dead weight.		
		Food. Dry matter.	Total cost.		Total cost.		Food. Dry matter.		Total cost.		Total cost.		
			Cash value.	As % of cost at 125 lb.	Cash value.	As % of cost at 125 lb.	Amount.	% of amt. at 10 weeks.	Cash value.	As % of cost at 10 weeks.	Cash value.	As % of cost at 125 lb.	
	lb.	lb.	pence.	%	pence.	%	lb.	%	pence.	%	pence.	%	
Weaning to effective service...	...	31·7	...	...	...	..	...	...	...	...	...	...	1
Effective service to Farrowing	...	41·75	63·61	...	...	...	...		..	...	...	...	2
Farrowing to Weaning ...	...	6·34	9·74	..	...	...	...	...	...	...	...	...	3
8–10 weeks	2·15	5·26	8·30	...	..	...	2·16	100·0	4·66	100·0	...	...	4
10–14 weeks	2·99	4·43	7·18	...	...	...	2·72	122·2	4·53	97·2	...	..	5
14 weeks to 95 lb.	3·79	4·26	6·55	...	9·92	...	3·25	138·2	4·72	101·3	7·14	100·0	6
95 lb.–125 lb,...	4·07	4·21	6·34	100·0	9·06	100·0	3·53	153·2	5·03	108·0	7·18	100·5	7
125 lb.–180 lb.	4·68	4·29	5·88	92·7	8·04	88·7	3·94	165·0	5·03	108·0	6·88	96·4	8
180 lb.–240 lb.	5·22	4·38	5·95	93·8	7·75	85·5	3·65	166·0	5·37	115·3	7·00	98·0	9
240 lb.–270 lb.	4·48	4·40	5·88	92·7	7·43	82·0	4·15	188·7	5·35	114·9	6·77	94·8	10
Column Nos. ... (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	

of food required per 1 lb. live weight gain at 240-270 lb. is approximately 190 per cent. of what it is at 10 weeks, the total cost per 1 lb. live weight gain is at the higher weight only 115 per cent. of the 10 weeks' cost. This is accounted for partly by the higher proportion of labour costs in the earlier stages and partly by the fact that the cost of food per lb. is necessarily higher for young pigs than for older ones. Even where only the live weight is concerned, therefore, the increase in cost per lb. of gain is not even approximately proportional to the increase in food consumed, as is generally assumed.

The costs so far mentioned refer only to those from weaning to slaughter, to which, however, has to be added the overhead charge of the cost of the pig at weaning. From the figures obtained in the present investigation and from other reliable sources this is found to be in the neighbourhood of 28*s*. Now if this sum has to be spread over a small amount, i.e. when the pig is slaughtered at a light weight, then the additional sum per 1 lb. of carcase produced which has to be added to the cost of food becomes proportionately very high. It is shown in fact, by comparing column 3 with either column 2 or column 8, that this decrease in overhead cost more than compensates for the increase in food consumed, and that if the food consumed (through the sow before farrowing) per lb. gain is estimated from the sow's previous weaning then it is actually found to decrease slightly at the higher weights.

Cost of Dead Weight Gains.—The relative profits at different weights are, of course, determined by the difference between the cost of production and the price obtainable. It is not possible, however, to obtain accurate figures for the price per lb. live weight at the different weights given in Table I, though the dead weight prices are available from the quotations at the Smithfield Market in London. It is therefore necessary to correct these prices to the equivalent price per lb. live weight, and this has been done in Table II by employing the best figures available for average carcase-dressing percentage.

TABLE II.

Smithfield Price Quotations.

Dead weight.	Average dressing percentage.	Live weight estimated from dead weight.	Average price per 1 lb.			
			Dead.		Live.	
			Pence.	% of price at 80 lb.	Pence.	% of price at 80 lb.
lb.	%	lb.		%		%
Under 80 lb.	66 0	Under 116.	12·21	100·0	8·06	100·0
80–120 lb.	71·6	116–164	11·23	92·0	8·04	99·8
120–160 lb.	73·4	164–219	10·25	84 0	7·52	93·3

The salient feature of this table for our purpose is the last column showing the percentage of the cost at 219 lb. and over to the cost at 116 lb. This will be seen to be 93·3 per cent., and is to be compared with column 5, Table I, where the percentage of total cost in the 180-240 lb. period is 93·8 per cent. of the cost at 125 lb. For all practical purposes these two percentage figures are identical, and show that the proportion of cost to selling price at what are commonly recognised as "small pork" and "bacon" weights is the same.

General Conclusions.—The higher price per lb. dead weight obtainable for small pork pigs, coupled with the way in which experimental figures have been unwittingly used to exaggerate the cost of production at heavier weights, is responsible at times for a considerable amount of unprofitable pork production. It is obvious that there are certain times when the margin between bacon and pork prices makes the latter more profitable, but over the whole of a price cycle this margin will be seen from Table II to be less than is generally imagined.

Again, it has to be realised that in the case of a small pig not only has the cost of the weaned pig to be spread over a small carcase weight, but the general overhead expenses of the farm or of the pig section have also to be added to a smaller general turnover unless pigs are farrowed and fattened all the year round so as to keep the accommodation fully occupied. Where this is done, however, it will be found, if careful records are kept, that the litters farrowed in November, December and January are almost invariably much below standard, and in the opinion of the writer the attempt to get over the difficulties of a small turnover in this way is not justified by results.

Finally it has to be explained that in the case of the herd at the Duthie Experimental Stock Farm, from which the present figures have been taken, the pigs were bred and fattened in the same place, thus obviating any general loss of condition as a result of passing through one or more markets. Where markets or dealers are involved it is unreasonable not to expect a check of some weeks in the growth of the piglings, and where this takes place, it is open to considerable doubt whether any profit can be reckoned on until the pigs have been carried on to weights in the neighbourhood of the bacon limits.

Where pig-keeping forms a regular part of farming activities irrespective of seasonable price fluctuations, it would appear, therefore, to be wisest to aim at producing bacon pigs. There is considerable evidence [1] that if this is done there should be no difficulty in utilising a good bacon type of pig for the production of the best class of small pork when the margin between prices makes this advisable. The alternative policy of producing mainly small pigs of a special type for the pork market has the disadvantages that the extra profit over a price cycle is, on the present figures, very problematical, and that this type of pig when carried to heavier weights is definitely unsuitable for producing bacon of the best quality.

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[1] Report of the Scottish Pig Industry Committee, 1927. Scot. Agr. Org. Society, 5 St. Andrew Square, Edinburgh.
Davidson, H. R., Variations in Carcase Type for Pork and Bacon, *Scot. Journ. of Agriculture*, vol. x, No. 4, Oct. 1927.

INSECT PESTS.—No. X.

R. STEWART MACDOUGALL, M.A., D.Sc.

LEAVING the Chafer beetles, reviewed in the October number of the JOURNAL, we come to two other tribes of beetles that have five joints to their feet, although there can be considerable variation, namely, the Club-horned beetles and the Saw-horned beetles.

THE CLUB-HORNED BEETLES.

In this tribe of beetles the antennæ are club-like, being swollen or gradually thickened towards the tip. The tribe contains families differing in habitat and mode of life. There is an aquatic family, and also semi-aquatic forms like the Turnip Mud Beetle. Here also come the Rove Beetles, the Burying Beetles, the Raspberry Beetle, the Larder Beetle, and several species destructive to grain.

The Rove Beetles (Family *Staphylinidæ*).—This is a family of beetles helpful rather than harmful in agriculture, adult and larva being predaceous on insects, worms and snails, or feeders on carrion or decaying vegetable matter. The family is very large, rich in species, and varying greatly in size of beetle. An excellent family character is the very short wing-covers or elytra, which are so short that they reach only to the end of the thorax, leaving the great part of the body uncovered; the exposed hind joints are very mobile. Many of the species fly well, but the flying wings are not visible when the beetles are resting, being tucked away beneath the short wing covers.

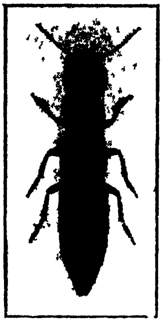

FIG. 1.
Ocypus olens. Natural size. (From Nature.)

A well-known beetle of the family is the Cocktail Beetle or devil's coachhorse. The common name cocktail is due to the habit of the beetle, when annoyed or alarmed, of erecting the tail-end of the abdomen and bending it over the body. This threatening attitude is not altogether mere bluff, for the beetle at the same time gives out an offensive and defensive evil-smelling fluid from a pair of glands at the tip of the tail, hence the book name of the beetle *Ocypus olens* (stinking or smelling).

The beetle does not run away, but assumes the offensive with open jaws.

O. olens is dull black in colour (Fig. 1); head as broad as thorax; antennæ dark with the end joints swollen and rather lighter in colour; thorax square. The larva can be confused with that of a ground beetle,[1] but the legs are not so well developed and the feet end in a single claw. This Rove beetle is common in decaying vegetable matter in the soil, under stones and clods, and under leaves; sometimes it is found indoors. In addition to feeding on decaying matter the beetle attacks such soft-bodied invertebrates as it finds in the soil; its mandibles are not powerful enough to break the skin and draw the blood of a man, but the beetle, if given the chance, will have a good try.

Burying or Sexton Beetles (Family *Silphidæ*).—The Sextons come near the Rove beetles, but the wing covers are not short. Most of them feed on decaying animal or vegetable matter. An easy example to find is the Sexton beetle (*Necrophorus*). Male and female, with others also, can be found digging round and underneath the body of some small dead animal which they may succeed in burying. The female lays her eggs in the buried carcase and the grubs on hatching feed on the carrion. Bastin [2] quotes a record of four burying beetles which, kept under observation, buried in fifty days " four frogs, three small birds, two fishes, one mole, two grasshoppers, the entrails of a fish, and two pieces of ox liver."

Another family (*Dermestidæ*) contains the Larder beetle (*Dermestes lardarius*), occasionally, with its repulsive hairy larva, very troublesome in stores and larders. The eggs are laid on bacon, ham, meat, and the larvæ feed on these and on dry animal food products. Cheese is very attractive to the beetles. In leaving the Club-horned beetles one must note a typical vegetarian, an enemy of fruit, namely, the Raspberry beetle.

The Raspberry Beetle (*Byturus tomentosus*) is a small beetle measuring one-sixth inch in length. The colour is brown or black-brown, and the body is in fresh specimens thickly covered with a yellowish grey pubescence (hence the name *tomentosus*). When the beetle is older and has been exposed for some time in the open the pubescence may be quite rubbed off, and the beetle looks dark brown. The clubbed antennæ (a lens should be used) are yellow-red.

The larva is a six-legged grub with biting jaws; at the hind end are two curveal spines, and between them, on the under side, a muscular projection of service in locomotion; the colour is yellowish and each joint has brown marking on the upper surface. Full-grown, the grub measures one-third of an inch. *B. tomentosus* is an enemy to the flowers and fruit of chiefly raspberry, blackberry and loganberry, but other Rosaceous flowers are attacked. The beetles themselves are destructive to bud and flower; the grubs tunnel into the receptacle of the fruit and the fruit itself. It is unpleasant to meet them at table.

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[1] The Ground Beetles (*Carabidæ*) were described in the October number of the JOURNAL.

[2] Insects—their Life-histories and Habits, by Harold Bastin (Jack).

My records on Byturus are chiefly from middle and south England; in one case my correspondent reported the loss of 70 lb. of loganberries. Beetles quite fresh in appearance have come to me from May on through June. Later the complaints were of the grubs.

The adult beetles fly well. The female lays her eggs in the opening flower-buds. The grub on hatching tunnels into the receptacle and later enters the fruit, which if not quite spoiled may be misshapen. The full-fed grubs leave the fruit, and pupate in the soil at the foot of plants or in crevices or shelter places in the canes under cover of a protecting cocoon. The winter is so passed and the mature beetles come away in May and June.

Control.—The beetles, active enough in sunshine, are sluggish in dull weather, when they should be shaken off the plants on to cloths, sacking or boards that have been tarred. Pupæ should be destroyed during the resting season, autumn to May, by disturbing the surface soil underneath the plants that were infested in the summer. The shelter places in old canes and poles should not be forgotten.

THE SAW-HORNED BEETLES.

This tribe of beetles is characterised by the antennæ being saw-like on their inner edges (a lens is necessary). Here come the death-watches or furniture beetles and their allies; the soldiers and sailors; the click or skip-jack beetles and the glow-worms.

The soldiers and sailors, so named from some being red or reddish and others some shade of blue, have the outer protecting covering of the body and also the wing covers softer than usual (typically the external covering and wing covers of beetles are very hard).

The family name is Telephoridæ. Telephorus adults and larvæ are generally described as carnivorous in diet, the mature beetles feeding in the open on aphides and other insects infesting plants, while the jawed six-legged grub preys upon insect larvæ and sluggish soft-bodied forms to be found in the soil. There are records, however, of the grubs being destructive to wheat grains and seedlings, and Miss Olga Payne [1] has experimentally proved this. In Miss Payne's research on Telephorus flesh food was willingly accepted, but certain kinds of vegetable matter were willingly taken.

Family Elateridæ.—Farmers, smallholders, and gardeners, and allotment-holders are all too familiar with wireworms, which are the larvæ of certain beetles of this family Elateridæ. The wireworm beetles are known as *Elater* beetles or *Click* beetles or Skip-jacks. The adults have a spine on the under side of the first joint behind the head; this spine points backwards and fits into a groove on the underside of the second joint of the thorax. When the beetle is on its back it arches the middle part of its body off the ground, and in doing this the spine comes out of its groove. The beetle then suddenly straightens itself and the spine is forced back into the groove with a click; at the same time the beetle bumps the ground in straightening itself, and is bumped up a short distance into the air. In this manner the beetle turns round and lands gracefully on its feet. If one hold a skip-jack by one end, under side up, one can observe part of the movement and hear the click.

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[1] Notes on *Telephorus rufus* and its Varieties, by Olga G. M. Payne, M.Sc., *Journal of Economic Biology*, December 1914, vol. ix, No. 4.

On the Life-history and Structure of *Telephorus lituratus*, by Olga G. M. Payne, M.Sc., in *Journal of Zoological Research*, April 1916, vol. i, pt. 1.

The Family characters are: head more or less sunk in the thorax (the three joints behind the head form the thorax); the hind angles of the first joint of the thorax project backwards; the antennæ are placed low down on the forehead and are saw-like or comblike (use a lens). There are many different species in the family but all are not harmful to crops; indeed only a few have been definitely proved as destructive.

The larvæ of Elateridæ vary considerably in habit. Some are very harmful at the roots of living plants; some are found in compost heaps; some under damp bark and rotten wood, and others in the tunnels of destructive bark and wood-boring beetles.

The species proved to be destructive to farm or garden crops are not more than five or six and come in two genera, Agriotes and Athous.[1] Of the genus Agriotes the troublesome species are *A. obscurus, A. sputator* and *A. lineatus*.

The larvæ—the so-called wireworms—of these beetles are elongated and worm-like, with flattened heads and chewing mouth-parts. There are six legs—a pair on each of the first three joints of the body; these thoracic legs are short, with five joints, the last continued into a claw. On the underside of the last joint is a muscular process of service in locomotion. There are twelve visible joints behind the head, and these have horny shields on both upper and lower surface, so that the wireworm is hard to the feel. This horny covering is protective, and the only time the body is soft is just before and after a moult (the larva moults a number of times from the time of its hatching until it is full fed). The head carries toothed jaws, a pair of very minute antennæ, and on each side an eye spot. On each side of the second joint of the body and on joints four to eleven inclusive is a spiracle or breathing pore. While typically vegetarian in diet, wireworms, in the case of overcrowding, may, especially while in the temporary soft-bodied state, be preyed upon and killed by their neighbours.

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[1] Observations on the Larval and Pupal Stages of *A. obscurus*, by George H. Ford, M.Sc., in *Annals of Applied Biology*, Jan. 1917.

On the Life-history of Wireworms of the genus Agriotes with some Notes on that of *Athous hæmorrhoidalis*, Part I, by A. W. Rhymer-Roberts, M.A., in *Annals of Applied Biology*, Dec. 1919; and Part II in *The Annals of Applied Biology*, vol. 8, Nos. 3 and 4, Nov. 1921.

The larvæ of the genera named Agriotes and Athous are not difficult to separate if one examine them under magnification. Agriotes larvæ can be told from all the other genera of wireworms by the body being rounded and by the last joint being cone-shaped and pointed and showing on its upper surface two small pits or depressions. These pits may have a sensory function. They are not breathing-pores as was once thought. There is another genus of Elater beetles in which the larvæ have rounded bodies and the shape of the last joint as just described for Agriotes, but the two pits on the upper surface of the last joint are wanting.

The larva of Athous has a more flattened body; the last joint is notched behind and has backwards-projecting prongs; between the two prongs a circular area is enclosed, the circle not being quite complete.

Numerous other Elateridæ larvæ are more or less like one another, but the nature of the last joint, its shape and sculpturing yield characters by which we can distinguish the larvæ.

Life History.—The adult beetles do no harm. They are found in the summer time, resting on flowers and on bushes or crawling on the ground. Rhymer-Roberts [1] finds Agriotes more frequently on the ground and Athous more in the open, flying and on plants. The females lay their eggs in the soil, entering it for the purpose; the eggs are laid, according to Rhymer-Roberts, at a depth of one-quarter inch to two inches. The favourite egg-laying place is among grasses. June and July are the usual months.

The larva in the first year of its life grows slowly but afterwards more quickly. There is a long larval life, viz. four or five years.

The full-grown larva makes a cell or chamber in the soil and pupates in this chamber. The pupal stage lasts for three weeks to a month, and in due course the beetles make their way to the surface to feed and mate. The depth at which pupation takes place is variable. Ford [2] says for *A. obscurus* three to twelve inches. Of fifteen pupæ taken by Rhymer-Roberts from sod-heaps only one was deeper than four inches. Perhaps the average depth may be taken at four inches, but they can be nearer the surface and can be deeper.

Wireworms are hardy but they cannot resist drying or dry conditions of soil, although of course they can do something to escape drought by going deeper, for they tunnel without difficulty. A certain amount of moisture is a necessity for their life; they can resist flooding for at any rate some days. Whether they feed all the year round or have a fasting period in November, December and January depends on the environment.

Wireworm larvæ are able to exist for a long time in soil that carries no crop and they seem to be able to endure long fasts.

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[1] On the Life-history of Wireworms of the genus Agriotes, with some Notes on that of *Athous hæmorrhoidalis*, Part II, by A. W. Rhymer-Roberts, in *The Annals of Applied Biology*, Nov. 1921.

[2] *Annals of Applied Biology*, Dec. 1919.

Thus Ford,[1] in an account of his experiments, writes concerning *A. obscurus*:—"It is very difficult to starve these wireworms. Of ten large wireworms placed in sifted soil without food on November 3, 1914, nine were present on January 22, 1915, and seven on March 8, 1915. The three missing ones had probably been eaten by the others. These seven larvæ had existed in a soil free from any vegetable matter visible to the naked eye for 125 days. One remained alive on May 4, 1915. Wireworms kept in soil not supplied with water and allowed to dry will die in a couple of days."

Rhymer-Roberts,[2] at Rothamsted, in a record of his experimental work writes :—"Larvæ have been kept for some months on a diet of vegetable compost during the spring and summer, and in the laboratory have frequently been kept in boxes for prolonged periods with no food other than decaying roots and the humus contained in the soil. They do not thrive under such a treatment as the last named, but life is maintained, and it is certain that nourishment is derived from the organic matter contained in the soil. On the other hand, provided that sufficient moisture is supplied, Agriotes larvæ are able to fast for a considerable time without apparent inconvenience."

The depth at which wireworms may be found in the soil varies considerably—from a few inches to between one and two feet according to the nature of the soil, the weather conditions—dry or wet or frost, and the kind and depth of the crop plant. On the whole they are shallowest with permanent pasture in consonance with the comparatively shallow-rooting grasses.

As regards the distribution of wireworms in the soil, there are variations according to the nature of the crop. In grassland and with cereals—the plants being more or less crowded—the wireworms are distributed generally, whereas with crops drilled at greater distances wireworms are found more or less in collections.

Crop Plants that Suffer.—The typical place for the wireworms of the species we are discussing is at and among the roots of grasses in permanent pasture, and weed-grasses in neglected areas. The plants are crowded together, they are vigorous, they are not allowed to exhaust themselves by profuse seeding, and the damage done by the wireworms does not show much, but when such land is ploughed the next crop can most surely be expected to suffer. Similarly, where in a rotation there are several years of temporary pasture followed by ploughing and a cereal crop, the young cereals are in great danger from wireworm.

During the Great War, with so much grass land that came to be broken up for allotments, the allotment holder had grievous experience with wireworm. There is practically no crop which does not suffer from wireworm attack, though some are preferred to others. Cereals, grasses, potatoes, mangolds, swedes, turnips (the young roots), peas, beans, tomatoes, strawberries, all suffer. Chrysanthemums and other flower plants are subject to attack. Sometimes the wireworm bores into the root and tunnels upwards. Wireworms also feed at the roots of a number of weeds, including some of the most troublesome.

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[1] The Larval and Pupal Stages of *Agriotes obscurus* in *The Annals of Applied Biology*, Jan. 1917.

[2] *The Annals of Applied Biology*, Dec. 1919.

Control measures.—The cultural measures that have an influence in keeping wireworm in check are the ploughing-up as early as possible—the earlier the better—of grass land that has to carry a new crop. A firm compacted soil is not favourable for the egg laying. Leaflet No. 10 of the Ministry of Agriculture says :—" If the land cannot be ploughed until winter or spring, the turf should be broken up—for instance by disc harrows—and then well buried. The greatest importance must be attached to the thorough consolidation of the land, which, in many cases, is only attainable after the turf has been well broken up. A deep firm seed bed will often enable the subsequent crop to withstand a wireworm attack." The rolling in the case of young cereals does something to prevent the larvæ from moving quickly from plant to plant. Spring, however, is a very busy time on the farm, and the constant rolling desired is not easy of attainment.

Young plants may be helped over the dangerous stage by forcing manures.

Cultivation as a very effective source of reduction and a destroyer of Wireworms.—Roebuck [1] has recorded striking results from his observation and experiments over a number of years, on a series of farms. From his Table I choose out two typical cases. The land in the two cases was pasture land, the first ploughed in the autumn of 1914 and the second in 1917, a series of crops being taken in successive years. The figures from 1914 onwards and 1917 onwards show a regular and continuous fall in the wireworm population per acre especially in the first year after cultivation. The figures represent the number of wireworms per acre.

Farm.	*1914.*	*1915.*	*1916.*	*1917.*	*1918.*	*1919.*	*1920.*	*1921.*	*1922.*
1	...	900,000	850,000	680,000	440,000	283,500	32,700	21,800	6,000
2	...	...	...	...	350,000	228,700	94,000	50,000	15,000

As the wireworm in its larval condition may live for five years, and as probably all stages from one year to five years would be present at the beginning, the numbers are likely to fall progressively if the conditions for egg laying were disfavoured. By five years the number of wireworms per acre in these recorded observations had fallen to a percentage negligible for the grower.

Roebuck suggests that cereals and broadcast crops, established plants, and strong spreading rooted crops will be tolerably safe if the wireworm content in the soil does not exceed 100,000 to 200,000 per acre, that below 100,000 there is little danger and that under 50,000 per acre their presence can be neglected.

Baits.—Baits of plant material attractive to wireworms are often recommended as a means of trapping the larvæ. On a field scale such baiting may seem hardly practicable, but on a garden scale and under glass recent experimental work justifies the setting of baits if this method be practised in combination with the introduction of a poison to destroy the wireworms that have collected at the baits. The method has been worked out in America[1] by Campbell, Spuler, and Horsfall and Thomas, and following this work success has attended experiments in England carried through by Miles and Petherbridge[2] in 1925 and 1926, when at least 10,000 wireworms were reviewed in the experiments. Sufficient proof at any rate has been given that, on a limited scale in the open, and under glass, baits can be used successfully to attract to them wireworms, and that it is an economically practicable measure to assemble, and then to destroy these by the application of a toxic agent.

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[1] Destruction of Wireworms, by A. Roebuck, in *The Journal of the Ministry of Agriculture*, Feb. 1924.

The successful toxic agent was calcium cyanide, which in the presence of soil moisture gives off poisonous hydrocyanic gas. The byeproducts are not harmful but beneficial to plants.

Miles and Petherbridge experimented with a number of different baits. The most successful were the germinating grains of wheat and oats and also bran. Bran proved attractive for about a fortnight then moulded, whereas the germinating grain continued attractive. Slices of potato were not so attractive.

As conditions for successful baiting the area must be cleared of weeds to reduce the amount of food available for the wireworms and limit their choice; the broken up turf in ploughed land should have had time to decay (say a year); and the baits should be put in 2 to 4 feet apart and at a depth of 2 to 3 inches. In the experiments baits were drilled in, or, in glass houses, put in with a bulb-planter.

Calcium Cyanide as the toxic agent.—Experiments proved that in field treatment wireworms are killed by the use of calcium cyanide, and this without injury to the crop plants. The calcium cyanide used was in granular form and put in by a hand-drill. Spring is recommended as the most favourable time for the work. The cyanide should be applied in a fortnight from the time of baiting (a longer time should be allowed if frost intervenes), when the wireworms will have collected in greatest numbers; and at a depth of 4 inches, i.e. under the baits.

In the experiments of Miles and Petherbridge 2 to 3 lb. of calcium cyanide per 100 yards of bait used destroyed 75 to 100 per cent. of the assembled wireworms.

Are there times or seasons when wireworms come within easier reach of treatment in the practice of control measures?—Earlier in this article it has been stated that there is considerable variation, according to crop and climate, as to the depth at which wireworms are found. Whether there be a seasonal movement upwards and downwards has also a practical bearing. *Roebuck, Thompson, Morris, Theobald and M'Gowan, Rhymer-Roberts,* Miles and Petherbridge have all recorded observations. These are not always in agreement, but on the whole, while admitting that the larvæ are to be found in the surface layers at any season of the year, we will not be far astray in making up a calendar for wireworms something like this.

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[1] R. E. Campbell: *Journal of Economic Entomology*, vol. 17, 1924. A. Spuler: *Journal of Economic Entomology*, vol. 18, 1925. Horsfall and Thomas: *Journal of Economic Entomology*, vol. 19, 1926.

[2] The Control of Wireworms in Glass Houses, by Herbert W. Miles, M.Sc., N.D.A., and F. R. Petherbridge, M.A., in *The Journal of the Ministry of Agriculture*. Jan. 1927, and Investigations on the Control of Wireworms, by Miles and Petherbridge, in *The Annals of Applied Biology*, vol xiv, No. 3, Aug. 1927.

In January the wireworms will be in greatest number in the area 6 to 9 inches deep.

In February the numbers will be greatest in the neighbourhood of 4 inches.

In March, April, May, they will be in greatest numbers in the surface layers to the 3 inch level.

From June to August, with variations according to food plant and soil, the wireworms will be in greatest number slightly deeper than 3 inches.

In September and most of October in the 3 to 6 inch region.

Towards the end of October their numbers will increase in the 6 to 9 inches.

In November and December the highest percentage will be in the 6 to 9 inches area.

For some interesting graphs indicating possible seasonal movements of wireworms the readers are referred to the article on the control of wireworms by Miles and Petherbridge in the *Annals of Biology* for August 1927.

Aid from Nature.—The rook, the jackdaw, the black-headed and other gulls and the starling habitually destroy great numbers of wireworms; other birds do so incidentally. We have little or no knowledge as to what extent wireworms are parasitised by insects.

Glow-worms.—These, along with the Fireflies of other countries, are neither worms nor flies but true beetles. The larger forms belong to the family we have just been considering—the Elateridæ. Our British Glow-worm, well named *Lampyris noctiluca,* comes in the neighbouring family, the Lampyridæ. In the glow-worm egg, larva, pupa, as well as the male and female beetle are luminescent (luminescence should not be confused with phosphorescence). The light comes from near the end of the under side of the abdomen, save in the case of the egg, where it is displayed all over the general surface. One is tempted to tell a full story of these living lamps :

> ". . . by whose clear light
> The nightingale does sit so late
> And studying all the summer night
> Her matchless songs does meditate" ;

but this is not the place to tell the story. A few salient points can only be mentioned.

The eggs are laid among grass and moss in moist places. The larva—the autumn and winter are passed in the larval stage—is a 6-legged grub and is carnivorous in diet, softening the parts of its prey by the aid of an exuded liquid and then sucking in the resulting fluid material. The full grown larva pupates in spring. The male beetle is winged and a good flier, the female—whose light is brighter—wingless.

The glow-worm's light, whether of male or female, is a love signal, and it is not altogether fanciful to think of the female keeping her light burning—a wise virgin—until she has a circle of attracted males from whom she may make choice of a mate. A happy writer has compared the attracting light to the dress of the cock pheasant, the song of the nightingale and the court dress of the debutante.

The luminescence of the glow-worms and the fireflies is the most economical of all light. It is cold light, a 100 per cent. light, none being dissipated as heat or electric or other vibrations. The interested student may have opportunity to observe the incidence of the glow-worm's light when in a thunderstorm the lightening flashes, and will seek opportunity to find if any response from the glow-worm attends the flashing of an electric torch.

WEEVILS.

We pass over the next great Division of beetles, those with a varying number of joints to their feet, as though numbering in it such forms as the mealworm beetles and some other species very destructive to flour and stored comestibles, we do not find agricultural field pests among the British examples. We therefore pass on to the Division Tetramera, beetles with seemingly only four joints to the feet. Of this Division the most important for the agriculturist and the fruit-grower are the Weevils, a series of beetles where the head is drawn out or elongated into a snout or proboscis at whose tip the biting mouth-parts are situated. By this character the adult beetles are easy to tell; their grubs or larvæ are also characteristic.

The larva in all these snouted beetles is legless; the head is rounded, brown or dark in colour, and carries biting or gnawing jaws; the larvæ feed under cover in buds or stems, or roots or leaves, or fruit or seed, and in consonance with their hidden position they are cream-coloured or yellowish-white; the body is compact, and curled and wrinkled.

The pupa lies protected, sometimes in a cocoon or bed, in a hollowed out position of the food plant, or in the soil.

The Turnip Gall Weevil (*Ceuthorhynchus pleurostigma* (*sulcicollis*)).—This weevil (Fig. 2) measures less than one-eighth inch in length; it is oblong-oval in shape and black in colour, but in fresh specimens the beetles do not look quite black, because the upper surface of the body carries a greyish pubescence and the under surface lighter scales. There is a snout, which is slightly curved. The thorax (the part of the body behind the head) narrows from behind forwards, and has a distinct groove (use a lens) running down the middle of the upper surface. This weevil is an enemy of cruciferous plants, not only cultivated species like turnip, swede, cabbage, savoy, brussels sprouts, but also weed crucifers like charlock, whose roots may often be found "galled" by this insect.

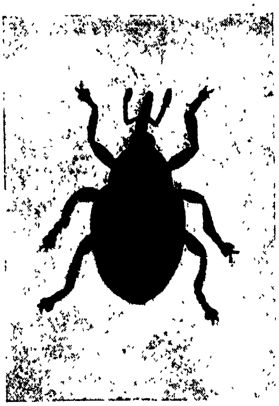

FIG. 2.
The Turnip Gall Weevil. (Magnified.)

Life history.—The female lays her eggs under the skin of the root and then pushes them into position—as so many weevils do—by means of her snout. The grub on hatching begins to gnaw the root, and this and its irritating presence give rise to a swelling or gall which increases in size with the growth of the larva. Each swelling holds one grub. (Fig. 3.)

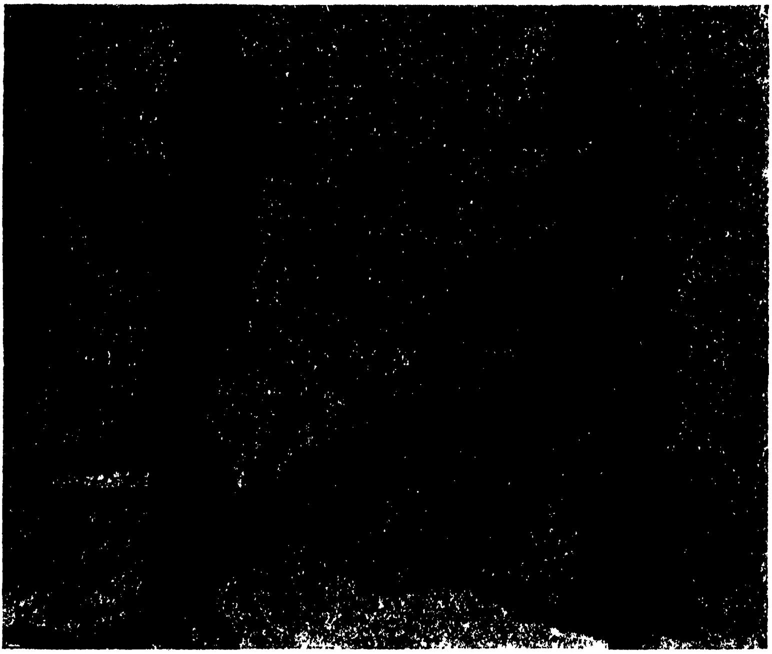

FIG. 3.
Roots of Savoy with Galls of the Turnip Gall Weevil. (From Nature.)

When the larva is full grown it leaves the gall and enters the soil, where it pupates under cover of an earthen chamber made of glued-together particles of soil.

Whether the generation is annual or whether there be more generations than one in a year is in dispute. We certainly find adults and larvæ at varying times in the year. Theobald states that in summer the whole life cycle can be completed in fifty days. On the other hand, if overwintering be in the grub stage, this time will be greatly lengthened.

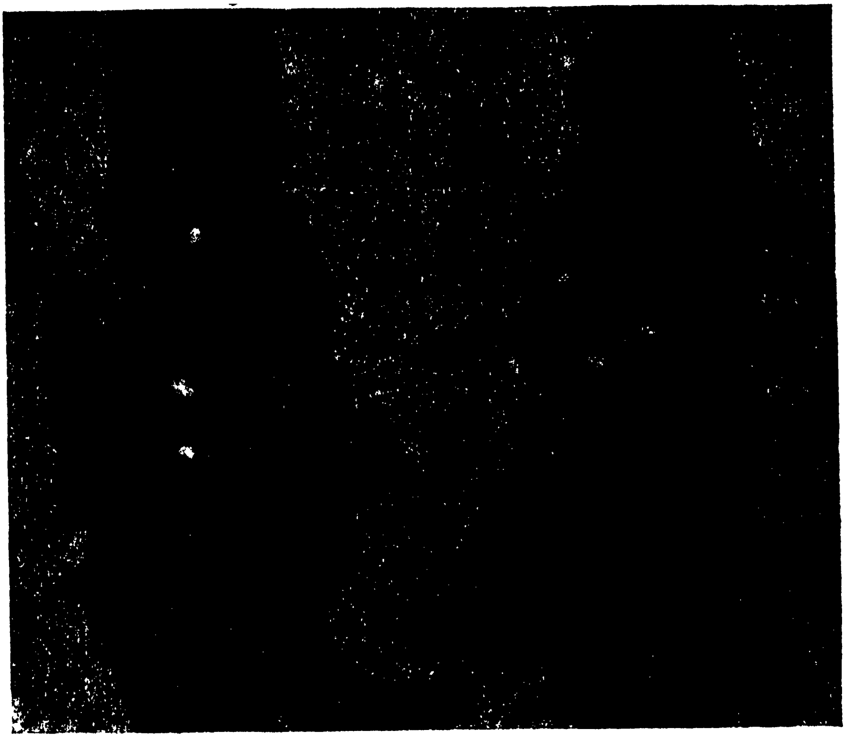

FIG. 4.

Section through root of Savoy to show Galls and Larvæ of Turnip Gall Weevil. (From Nature.)

Leaflet 303 of the Ministry of Agriculture [1] states there may be two broods in the year, one which lays its eggs in spring and early summer on charlock and seedlings of the cabbage tribe, and a second in late summer which chiefly selects the young plants of various " winter-greens." Further, the leaflet quotes Isaac as stating that the beetle is single-brooded and divided into two races, one attacking cultivated plants, the other weeds such as charlock.

A full and exact account would form an interesting and not difficult piece of work for the agricultural zoologist.

Effect on the Plant.—Poor plants and plants in poor soil and conditions will remain poor or die off. I have known cases, however, where, in favourable environment, areas that earlier showed even a severe infestation yielded at the finish quite a good crop.

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[1] Also Collected Leaflets on Insect Pests of Farm and Garden Crops, Ministry of Agriculture and Fisheries.

Control.—Avoid a crucifer crop in the year following bad attack.

Plough deeply land where there has been severe attack.

Do not prick-out galled young plants.

Do not throw down and allow to lie infested cabbage stumps and galled plants that have been removed, as, if these are exposed to moisture, the grubs may complete their development.

Confusion with Finger and Toe.—It is not an uncommon question as to how to distinguish Turnip Gall Weevil attack from Finger and Toe. The two should not really be confused as this table shows.

Finger and Toe.	*Gall Weevil.*
Swellings due to attack by a fungus (at any rate by a Myzomycete).	Swellings due to the grub of a beetle.
Turnip very misshapen and broken up into a series of elongated swellings suggesting swollen fingers or toes.	Turnip not broken up, but the swellings are rounded. Several may run together to give rise to a more irregular appearance. (Fig. 4.)
Swellings soft.	Swellings hard and on being cut show a grub. If the grub has become full-grown and left, a small hole will remain.
An unpleasant odour.	No unpleasant odour.

A smaller Ceuthorhynchus weevil, *C. contractus*, measuring only one-sixteenth of an inch in length, is sometimes very destructive to the very tiny seedlings of turnip and cabbage.

Note.—The figures which are Dr. Stewart MacDougall's are by the courtesy of the Highland and Agricultural Society.

THE VALUE OF DRIED POTATOES FOR PIG FEEDING.

A. CRICHTON, W. GODDEN and W. THOMSON,
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IN ordinary practice raw potatoes cannot be stored for more than about nine months and a proportion of the quantity remaining in hand when the new crop comes on the market cannot be utilised. In normal years the quantity so wasted is not very considerable, but in the spring of 1930 thousands of tons could not be marketed and a large proportion was allowed to go to waste. As a result of tests previously carried out to determine the feeding value of potatoes, it was found that one ton of fresh potatoes was equal in value to about 5 cwt. of barley.[1] It was therefore suggested that if the surplus potatoes could be dried at a reasonable cost it might be possible to store and utilise the dried potatoes for feeding purposes, providing the drying process did not seriously affect their feeding value.

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[1] Surplus Potatoes, *The Scottish Journal of Agriculture*, 1930, *13*, 30.

At the request of the Department of Agriculture experiments were carried out at the Rowett Research Institute to determine the effect of drying on the feeding value of the potatoes, and to ascertain whether these dried potatoes could be economically embodied in a ration for feeding pigs.

In the spring of 1930 a few tons of surplus potatoes were sliced and dried at the Anglo-Scottish Beet Sugar Factory, Cupar, Fife, and the dried potatoes were tested in a series of experiments against (1) boiled fresh potatoes and (2) maize. In all the experiments the foods being tested were fed in conjunction with a meal mixture consisting of :—

Basal Ration:

Ground maize	30 parts.
Ground barley	17·5 ,,
White sharps	22·5 ,,
Ex. soya bean meal	20 ,,
Mineral mixture	2 ,,

Throughout the experiments 2¼ lb. of this mixture plus 5 lb. of separated milk was fed per pig per day, the boiled potatoes, dried potatoes or ground maize being mixed with this supplement and increased daily according to the animals' appetite. Potatoes and maize being low in protein and rich in carbohydrates, the nutritive ratio of this ration became automatically wider as the animals consumed increasing amounts of potatoes or maize. This widening ratio is in accordance with the requirements of the growing pigs. The method of feeding is a modification of that worked out by Professor Lehmann of Gottingen to which reference is made in a previous article in this JOURNAL.[1]

The percentage dry matter in the foods tested was as follows :—

Boiled potatoes	18·0
Dried potatoes	85·2
Ground maize	87·0

It will therefore be seen that the dried potatoes contained practically five times the dry matter of boiled potatoes and slightly less than that of maize. The fresh potatoes before boiling contained 16·8 per cent. dry matter, the normal figure for fresh potatoes being 23 to 24 per cent. dry matter. The low figure for dry matter in this case may be accounted for by the fact that the potatoes had been in the pit from October 1929, and were therefore considerably sprouted.

Digestibility Tests.—It is impossible to test the digestibility of potatoes alone, as potatoes do not form a complete ration for a pig. Dried potatoes in the one case and boiled potatoes in the other were therefore added to the basal ration already mentioned and the digestibility of the respective rations was then compared. Boiled potatoes were used, because they are more digestible by the pig than raw potatoes. The following table shows the averages of two tests :—

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[1] *Supra*, p. 72.

TABLE I.

Digestibility Coefficients of whole ration including Potatoes.

	Dried potatoes.	*Boiled potatoes.*
Dry matter	86·3	86·8
Protein	77·4	79·3
Oil	49·0	52·0
Fibre	46·5	51·3
Carbohydrates	88·8	89·4

From these figures it would appear that the boiled potatoes are rather more digestible than the dried potatoes. The differences, however, are so small that they are within the limits of experimental error. It can be taken that the drying of the potatoes does not seriously affect their digestibility.

Feeding Experiments.—*Experiment No.* 1.—In this experiment three groups of pigs comparable as regards age, sex, weight and breeding were used. All food was soaked for 2 to 3 hours prior to feeding. It was found that the dried potatoes soaked quite readily in 2 hours, taking up about 3 times their weight of water in that time.

The following table gives the method of grouping, rations and the results of this experiment, which lasted from 17th July to 25th September 1930.

TABLE II.

	GROUP I.	GROUP II.	GROUP III.
	Basal Ration + Boiled Potatoes *ad lib.*	Basal Ration + Dried Potatoes *ad lib.*	Basal Ration + Ground Maize *ad lib.*
No. of pigs in group ...	8	8	8
Av. weight, 17th July 1930	95·5 lb.	93·7 lb.	95·0 lb.
Av. gain (70 days)	82·8 ,,	84·0 ,,	82·4 ,,
Av. gain per pig per day ...	1·18 ,,	1·2 ,,	1·17 ,,
Lb. dry matter consumed per lb. gained	3·28 ,,	3·12 ,,	3·24 ,,
Feed cost per 1 lb. gain ...	3·28*d.*	3·13*d.*	3·32*d.*

The feed cost per lb. gain is calculated on fresh potatoes at 1*s.* 6*d.* per cwt. ; dried potatoes at 7*s.* 1*d.* per cwt. ; maize at 7*s.* 2*d.* per cwt.

From these results it will be seen that the daily gain was practically the same in all groups, the dry matter consumed per lb. live weight increase being slightly lower in the case of the dried potato group. The amounts of boiled potatoes, dried potatoes and ground maize consumed were 5,067 lb., 976 lb., and 1,078 lb. respectively, equal in dry matter to 912 lb., 831 lb., and 937 lb.

The dried potatoes were eaten quite readily. At the finish of the experiment the boiled potato group was very even in appearance and weight, and not over-fat. The dried potato group was also very even in appearance and weight, but was somewhat fatter. The maize group was very uneven in appearance and weight, five pigs in this group having put on weights of over 1¼ lb. per day during the experiment; they were very much fatter than the pigs in the other two groups. The remaining three pigs in the maize group put on weights of just over ½ lb. per day during the experiment. It would appear therefore that the bulky potato rations were better suited for producing pigs of more even size, the animals on the more concentrated maize ration, owing to their excess of fat, being perhaps of less value as bacon pigs.

Experiment No. 2.—In this experiment over a period of 60 days, dried potatoes were again tested against boiled fresh potatoes. Two groups of eleven pigs each were used, the average weight at the commencement of the experiment being 98·6 lb. At the end of the experimental period the dried potato group was fatter, had put on more weight per 1 lb. dry matter consumed, and appeared to be in a more thrifty condition than the group on boiled potatoes. The figures were :—

	Dried Potatoes.	Boiled Potatoes.
Daily gain per pig per day	1·48 lb.	1·24 lb.
Lb. dry matter consumed per 1 lb. gain ...	3·48 ,,	3·89 ,,

Experiment No. 3.—This experiment has now been running 60 days. Three groups of seven pigs each were used, dried potatoes being again tested against boiled potatoes (1930 crop) and ground maize. The average weight of the pigs at the commencement of the experiment was 59·4 lb. Up to the present the results are :—

	Dried Potatoes.	Boiled Potatoes.	Ground Maize.
Average gain per pig per day ...	1·23 lb.	1·2 lb.	1·34 lb.
Lb dry matter consumed per 1 lb. live weight increase ...	2·84 ,,	2·62 ,,	2·51 ,,
Feed cost per 1 lb. gain ...	2·91*d.*	2·61*d.*	2·8*d.*

(The feed cost was calculated on the same basis as for experiment No. 1.)

In this experiment the dry matter consumed per 1 lb. live weight increase and feed cost are slightly less than in the previous experiments. This is due to the fact that younger pigs were used, experiments having shown that the food consumption per 1 lb. live weight gain increases with the age of the animal. The results from experiment No. 3 confirm those of the previous experiments.

The method of feeding in these tests provides an interesting demonstration of the quantity of boiled potatoes that can be consumed by pigs. In the first experiment over 2¼ tons were consumed by eight pigs in 70 days, pigs of 170 lb. weight eating as much as 21 lb. of potatoes per day.

The results of the three feeding experiments are in broad agreement, and seem to warrant the following conclusions :—

(1) The drying of potatoes does not appear to affect materially their digestibility or food value.

(2) Good results can be obtained from feeding dried potatoes in relatively large amounts in a ration suitably balanced with concentrates rich in protein and minerals.

(3) Dried potatoes appear to be approximately equal in feeding value to ground maize. Fed weight for weight they produce a better type of bacon pig.

THE following article has been contributed by Mr. G. E. Fussell :—

An 18th Century Scottish Farming Author.

When I came across a reference in a secondhand bookseller's catalogue to *The Practical Farmer's Pocket Companion*, by Sir Archibald Grant, Bailey of Monyninch, I naturally looked up the bibliographies of agricultural writers to find out something about him. He is not mentioned in any of them, nor in the *Dictionary of National Biography*. I pursued my quest further, and found copies of both this book and of his *The Farmer's New Year's Gift to his Countrymen* in the British Museum. Since he is unknown to the bibliographers, a short note on his books, which are in reality little more than pamphlets, may be of interest.

Like most other farming authors of the 18th century he is anxious to show that he is a practical man, as no doubt he was. To support his claims to this practical character, he signs the earlier book in the somewhat fantastic manner then sometimes adopted, " In a letter from a Gentleman in the South of Scotland, who had long experience of the rules he prescribes."

The verbosity of the title pages of the 18th century books is well-known, and Grant tells us that he will describe the existing system of farming in Scotland and point out how it might be improved. Naturally, therefore, the little book opens with a discussion of the infield and outfield system then general. All the available manure was put on the infield and this was always cropped in the same way. Barley was sown on land that had been ploughed two or three times and dunged. Next oats were sown after a single ploughing, and last pease on another single ploughing. The rotation went on continuously. As much of the outfield as the farmer could manage was broken up each year, three or more crops of oats being taken with only one ploughing between each crop, after which the land was let fall down to grass for four, five or six years. It was not the practice to seed down with the last crop. The rewards of this system of farming were naturally very small, rarely above four or five times the seed on the infield and seldom exceeding twice, though very rarely three times, the seed on the outfield.

The obvious first step towards a remedy for this deficient system was enclosure, and Grant suggests that the expense might be defrayed by the landlord, the tenant paying an increased rent of 5, 6 or even 7 per cent. on the capital outlay necessary. The best method of fencing to his mind was a hedge and ditch, or a double ditch with a row of trees between the hedges. The fields should be from 8 to 12 Scots acres in size, and, if possible, each field should have a supply of water " within itself," a very modern desideratum. The land unsuitable for arable cultivation should be planted. He describes the best method of planting quicks, and advises that they should be protected from sheep and beasts while young.

The improving farmers of the time carried on a long disputation regarding the advantages of summer fallowing as against the cultivation of catch crops. Grant was a strong adherent of summer fallows. The first ploughing should be given at or before Christmas and should be as deep as possible, the fields being made as dry as may be. After the spring work was completed, the fallow should be cross ploughed and left as rough as possible. Immediately before the next ploughing the land should be harrowed quite flat with brake and small harrows; it should then be ploughed as often as convenient during the summer. The land should be laid up in 15 feet ridges in a straight line—the usual ridges by continuous ploughing had often taken the shape of the letter S—but should not be raised high. Drainage should be obtained by water " furrs," and, after sowing, these water furrows should be cleaned with the plough and spade.

As to manures, Grant recommends dung as good for all ground. Lime at 70 to 100 bolls an acre might be applied to new brought in land. Marl, if used, should be put on thick enough to cover the surface. He also mentions the other usual 18th century artificial manures—sand, seaweed, cleanings of ponds, peat ash, clay, &c.

Three different ideal rotations are given :—

	(1)	(2)	(3)
1.	Summer fallow, dunged or limed.	Summer fallow.	Summer fallow.
2.	Wheat.	Wheat.	Barley or wheat.
3.	Pease and beans, tare or vetches after 1 furr.	Pease as before.	Turnips.
4.	Barley on 3 furrs, one a winter fallow, with grass seed to rest 3 to 6 years at pleasure.	Barley.	Barley.
5.		Oats on 1 furr.	Oats with grass seeds to rest, or summer fallow to succeed.
6.		Summer fallow.	

Minor variations might be adopted if the farmer desired. The amount of seed in the middling way should be 3 b. of wheat, barley or peas and 4 b. of oats, but care should be taken to choose only the best seed. Wheat seed should be pickled in brine, and, after drying, should be dusted with lime. This treatment was also good for barley and peas, though seldom practised.

A good seeds mixture for a Scots acre was 16 lb. of red clover, 4 lb. of white, and 2 lb. of rye grass, but, if the intention was to pasture sheep, a few lb. of narrow leafed plantain should be added. The farmer is advised not to pasture cattle on grass seeds the first winter after they are sown. This mixture was, however, good for either hay or pasture, and could be used almost as might be wished, subject to the warning given.

Hay should not be too ripe when cut, nor should it be dried too much in the making, as in this condition it loses its feeding value. A good practice was to put salt with each stratum when building the stack. Other forage crops recommended are St. Foin, lucern, tares, parsnips, carrots and turnips. Potatoes were said to be good for nothing but swine, and these they would not fatten.

Brief instructions for the working and care of cattle are included. Horses or oxen should go seven hours a day in the plough or cart if yoked once; if yoked twice they should only work five hours at a stretch. They should be given as much fodder as they can eat. Oxen should be given two or more sheaves of unthreshed corn a day, horses three forpits of corn when yoked once, but a peck when yoked twice. Carthorses require more food than workhorses. Animals should be tended with great care. Their stables should be kept clean, and they should be given green fodder as soon as it is available in spring. They should be kept in the house in summer and fed on cut grass. Cows should have as much green meat as possible, otherwise they should be full fed.

When milk is scarce, calves may be bred upon hay tea and pease bread. Cattle turned into grass in May and kept well in summer will be good rough beef in November or December. Kept on hay and turnips during the remainder of the winter, they will be excellent beef in spring when meats are very dear. Kept well in winter, cattle will fatten on grass and be saleable in summer when beef is very dear. This was, of course, the system adopted by the English graziers at that time. Stall feeding should be done carefully. Only small quantities of forage should be given at a time, and these should be completely cleaned up before more is supplied.

If sheep are fed on turnips, they should be folded, and grassed a week before sale to prevent the mutton tasting of turnip. Ewes should never be milked more than sufficient to prevent their udders from festering, when the lambs are taken from them. Ewe's milk was sometimes used for making cheese or for mixing with goat's or cow's milk for this purpose.

A fairly lengthy discussion of planting the different kinds of trees follows, this being a favourite improvement in Scotland at the time, and Grant then turns to implements.

In his opinion " the Roderine (Rotherham?) and Common English, or Yorkshire ploughs are the best, having a broad, flat, or feathered share, which cuts the furrow below." It should run square on its bottom, and the furrows should be square, and set on edge. Ploughing should be as deep as possible. Observe carefully that all the furrows are regular and no places missed. Three good stout horses, yoked in line, are sufficient for almost any land, and sometimes two only are required. Two oxen and one horse in front form a useful team. It is a good plan to keep two ploughs.

Every farmer should have two brake harrows. The common harrows are principally used for harrowing in seed. Good rollers are also necessary. Barley, grass seeds, lint, turnips and all small seed ought to be rolled, and hayfields both in spring and after the hay is cut. In heavy land the crust formed after wet weather followed by great heat should be broken up with harrows, and weeds should be harrowed out and crushed with a roller.

Work horses should have chopped or cut straw with their corn, and barley should be fed as well as or mixed with oats. If dung is short after tillage, lay the land down to rest and refresh. Ashes or soot sown on young grass is excellent.

Grant mentions burning peat ashes, but refers his readers to the *Museum Rusticum,* Vol I, No. 51, for instructions how to do it. He adds that this publication contains several good pieces on husbandry, and thus leads us to suspect that he may have derived a good deal of his terse and almost axiomatic advice from that source.

The Farmer's New Year's Gift was written in the lazy winter evenings, probably because there was little else to do, and by the same token it was to be an occupation for the leisure of the farmer readers. It contains a number of moral reflections in its opening paragraphs, and for a few pages is merely general in its subject matter.

" A man even of knowledge in any science or business," says Grant, " improves much by converse upon the subject, although with persons of much inferior knowledge. . . . He profits, not only from what may be told or suggested by others, but from what he himself thinks or says upon such occasions; and therefore, clubs of farmers would be extremely useful; and at least in moonlight and long nights would be easy and no expense." This apothegm is, of course, as true now as when it was written, and many farmers have benefited by its practice.

Grant thinks that where farmers are ignorant they are always poor, and few will dispute his contention. He also maintains the necessity for good relations between the landlord and the tenant. Industry in the population is, he thinks, more important than a dense population. " Numbers of industrious people improve any country; they are a ready market without carriage, and will always consume in proportion as they gain."

Shelter is essential in the North, and so he advocates plantations. Good tools are imperative for every farmer, and each must maintain good roads on his land and have adequate carriages. A piece of advice that is still current is that people in a hurry to get rich often only succeed in getting poorer. He complains of too much oatmeal being eaten in the North. " Rye, bear and pease, are justly called the poor man's boll," he says, and mixed bread is, indeed, the more wholesome, a statement the modern man would take leave to doubt.

He makes other general observations and goes on to say that he will give extracts from a *System of Husbandry* lately published with his own observations, because his readers cannot all have access to such a book, and thus he will be useful to them. " The only useful or valuable purpose of having or reading books, is to make them useful," he adds.

In support of this argument he instances the improvement which had taken place in some districts within living memory. " Many countries, and especially the countries of *Norfolk* and *Lancaster,* were in my memory remarkably proverbial for bad grain and grass, poor tenants, and low rents; and by marle and good husbandry, all these have been improved, to be at least equal to any county in *England.*" Part of Lancashire's new prosperity was the result of growing potatoes. The county was one of the earliest to adopt this crop, and in Grant's day it produced immense quantities, " so that from *Liverpool* only, they send about twenty ships loading annually to *Dublin;* besides what they send to *Gibraltar,* and many distant parts beyond sea. . . ." It also used burnt parings of ground for manure, using the breast plough or slaughter spade to pare with, " but it may be much cheaper performed by a horse plough and a roller properly ironed to cut it across."

A curiosity of Grant's opinions is that Berkshire was the county of the best husbandry in England, a belief which we do not find confirmed elsewhere in contemporary writings nor subscribed to by modern authorities. He also tells us that in Stafford special crops were grown for feeding hogs, but this practice was also common in Leicestershire and other counties.

It is unnecessary here to discuss the information extracted from the *System of Husbandry* which was probably Hale's *Compleat Farmer,* an encyclopædic work compiled by a number of hands. There is, of course, little that is exceptional in Grant's two small books, but his terse and pithy style is much more suited to the public he was trying to approach than that of many of the farming writers of the time, and his remarks also bear the imprint of experience, while his non-inclusion in the agricultural bibliographies is a further reason for this note.

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Craibstone.

Notes from Agricultural Colleges.

Potatoes, 1930.—The first spot of blight this year was seen just before the middle of August. Dry sunny weather for a day or two prevented its spreading, and had this kind of weather continued it would undoubtedly have checked the disease. Heavy rain set in on the 17th, however, and this was followed by comparatively warm foggy weather, which favoured the spread of the disease, and soon all the leaves of the earlies and second earlies were destroyed. Continued favourable weather for the blight caused it to spread so rapidly to the late varieties that all except Irish Chieftain were down by the middle of September.

The nearer maturity plants were, the quicker they were affected; thus those that were well sprouted and planted early were affected before those that were unsprouted, and especially when planted late. Again, plants produced from large setts which had come through the ground earlier and were further advanced were affected before plants from small setts.

There was a considerable difference in the amount of diseased tubers among the different early varieties. The following table shows the percentages (by weight) :—

Duke of York	20	Witchhill	30
Di Vernon	1	Early Pink Champion	0
Ninetyfold	43	Entente Cordiale ...	23
Early Eclipse	1	Immune Ashleaf	21
Epicure	17	Mein's Early Round ...	22
Arran Crest	6	Edzell Blue	13
Arran Rose	26	Katie Glover	4
May Queen	28	Dargill Early	7
Puritan	50	Catriona	9

Results in previous years of blight had shown the comparative resistance of Di Vernon. This is probably the best all-round immune early variety for the lighter classes of soils in this district, where its quality is usually extremely good. It does not, however, appear to suit heavier soils so well.

A few boxes of several varieties were lifted on the 19th August, and the tubers appeared to be quite sound with no sign of blight. When examined a few weeks later, however, it was found that fully half were badly affected. Infection had taken place from spores in the air. Another section of the same varieties was lifted a fortnight later, when it was found that about 25 per cent. were affected.

In the case of second earlies and maincrops, it is interesting to note that, although all the leaves were destroyed, the tubers of many varieties were almost quite sound.

The following varieties were entirely free :—Ally, Arran Consul, Arran Victory, Golden Wonder, Irish Chieftain, King George, Kerr's Pink, Langworthy, Majestic, President and Tinwald Perfection, while others were affected as follows :—

British Queen, Bishop and King Edward ...	2 per cent.
Arran Banner, Arran Chief and Great Scot	4 ,,
Herald	10 ,,
Arran Comrade	21 ,,
Abundance	28 ,,

The value of a thick russet skin in assisting to resist blight was again well demonstrated this year in the case of Field Marshal, which had 3 per cent. compared with 14 per cent. in the case of Up-to-Date.

In such a season as 1930 the beneficial effect on the yield of planting well-sprouted seed was well demonstrated. The following figures show the effect of sprouting and also of planting at fortnightly intervals :—

Arran Banner.

	SPROUTED.										UNSPROUTED.									
	2 ins.		2 ins. to 1½ ins.		Small.		Diseased.		Total.		2 ins.		2 ins. to 1½ ins.		Small.		Diseased.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T	C.	T.	C.	T.	C.	T.	C.	T.	C.
March 15th	12	6	5	0	0	10	0	5	18	1	10	12	3	16	0	10	0	13	15	11
April 1st	16	8	3	18	0	10	0	12	21	8	9	19	7	7	0	16	0	16	18	18
,, 16th	12	1	5	10	0	12	0	18	19	1	10	8	6	14	0	12	0	10	18	4
May 1st	12	0	5	5	0	13	0	8	18	6	8	3	6	11	1	5	0	18	16	17
,, 16th	11	11	4	14	0	18	0	11	17	14	8	6	6	4	1	4	0	8	16	2
June 2nd	8	14	2	15	0	12	0	10	12	11	4	1	3	16	0	12	0	8	8	17
,, 16th	3	5	3	16	0	14	0	2	7	19	0	12	2	6	0	12	0	0	3	10

Golden Wonder.

	SPROUTED.								UNSPROUTED.							
	1¾ ins.		1¾ ins. to 1¼ ins.		Small.		Total.		1¾ ins.		1¾ ins. to 1¼ ins.		Small.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
March 15th	9	9	3	18	0	13	14	0	4	9	3	18	0	10	8	17
April 1st ...	8	13	4	6	0	8	13	7	4	6	3	19	0	8	8	13
,, 16th ...	9	14	3	5	0	8	13	7	3	16	3	18	0	10	8	4
May 1st ...	8	2	3	8	0	10	12	0	3	18	3	8	0	9	7	15
,, 16th ...	4	6	3	16	0	10	8	12	1	17	3	13	0	12	6	2
June 2nd ...	3	8	3	13	0	10	7	11	0	11	3	8	1	9	5	8
,, 16th ...	0	10	3	11	1	11	5	12	0	2	0	16	0	8	1	6

These results show the futility of judging a crop of potatoes by the appearance of the shaws. The latest planted, unsprouted plot had the most vigorous, darkest coloured and healthiest looking leaves, and in the case of the Golden Wonder the shaws were fully a foot taller than the earliest planted, sprouted plot. The stalks of the former, however, were very tender and broke down readily in high winds, and were entirely flat by the time they were affected by the blight. On the other hand, in the case of the latter the leaves were much lighter in colour and were almost ripe when destroyed by the blight. The stalks were also much stronger and stood well up. Even the unsprouted which were planted at the same time were taller, later in ripening and broke down to some extent.

There is no advantage in planting too early when the soil is cold, although it would appear that it would be well to plant Golden Wonder before such quicker growing earlier varieties as Arran Banner, &c.

As has been observed previously, the quality is greatly improved both by sprouting and early planting.

The following results were obtained in the trial where Golden Wonder was grown under good and poor conditions respectively.

Good Conditions.				Poor Conditions.			
Selected Seed. Well sprouted. Well manured.				Ordinary Seed. Unsprouted. Ordinary manuring.			
Ware.	Seed.	Small.	Total.	Ware.	Seed.	Small.	Total.
T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.	T. C.
10 5	5 10	0 16	16 11	4 6	5 3	0 10	9 19

These results show about the same relative increase due to the good conditions over poor conditions as last year, but a larger proportion of this increase is evidently due to the sprouting and less to the selected seed, as is indicated by the previous trial with sprouted and unsprouted seed and the following result obtained with two stocks of Langworthy, one with and another without Mosaic.

	Ware.	Seed.	Small.	Total.
	T. C.	T. C.	T. C.	T. C.
Without Mosaic	5 14	6 1	0 13	12 8
With Mosaic	3 18	6 5	0 12	10 15

This shows a total increase of 1 ton 13 cwt. per acre due to the selected stock, whereas in previous years the increase was fully 2½ tons per acre. This difference in the result is obviously due to the growing season being much shorter this year.

Several points have been observed this season in connection with the selection of healthy plants free from Mosaic. Injured plants often showed Mosaic whereas the neighbouring plants usually appeared to be quite healthy. Also, when one stalk was injured during cultivation it often showed Mosaic while the other stalks of the same plant appeared to be quite healthy. A good many stalks on different plants were purposely broken to see if Mosaic would show. In several cases, especially in the case of one selection, there was no sign of Mosaic.

It was also observed that in several cases the leaves on the small tender shoot that often arises late in the season in the axils of the branches had Mosaic, while the other leaves of the plant appeared to be quite healthy. In the case of the selection where the broken stalks were healthy, these tender shoots were also healthy.

Some of the plants with apparently the most healthy leaves were very late in forming tubers and produced a comparatively small crop. Plants that were somewhat lighter in colour and ripened somewhat earlier produced the best crop.

It would appear, therefore, in making selections as if there might be a danger of discarding plants with a slight thinness of leaf and preferring those that are thick and darker in colour. Comparative trials with the two types will require to be made for a few seasons before their relative merits can be fully estimated.

Last year seed of Golden Wonder was kept from several plants that had some peculiarity. In three cases, one stalk had Mosaic, the others being free. The resulting crop showed that about 25 per cent. were free from Mosaic, 10 per cent. were almost free, other 10 per cent. were badly affected, while the remaining 55 per cent. were somewhat affected, especially on the top leaves.

Plants which showed Mosaic on the top leaves again showed it as in 1929, except in the case of one plant where it was seen in only one leaf.

In 1919, a trial was started with several early varieties when part of each was lifted early and part when they were fully ripe. For a few years there was no apparent difference either in earliness or in crop, but after that the early lifted part began to sprout slightly earlier. This characteristic has gradually developed and now there is a distinct difference in the earliness of sprouting, and this has extended to the crop which now ripens earlier. When lifted early the crop from the early-lifted section was heavier than from the late-lifted section, but when lifted when fully ripe there was no appreciable difference between them. In both cases the plants were quite healthy.

In previous notes the effect of different sizes of setts has been discussed, and it was generally seen that the large setts produced the heaviest crops with the largest amount of seed size. In the crop of Arran Banner in 1929 there was such a large number of large tubers that it was thought it would be interesting to include a few weighing 12 oz. each in the 1930 trial. The following result was obtained when all were planted at 12 in. apart in the drill.

Size of Sett.	Over 2½ ins.		2½ ins. to 1½ ins.		Small.		Total.		Seed Planted.		Nett Crop.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
12 oz.	18	5	7	10	1	1	27	16	6	0	21	16
8 ,,	14	5	4	15	1	7	20	7	4	0	16	7
4 ,,	13	15	4	7	0	10	18	12	2	0	16	12
2 ,,	13	0	3	3	0	7	16	10	1	0	15	10
1 ,,	12	10	2	17	0	5	15	12	0	10	15	2
½ ,,	8	17	2	5	0	5	11	7	0	5	11	2
¼ ,,	4	5	2	0	0	3	6	8	0	2½	6	5½

This result corroborates those of the previous trials.

Several trials were carried out with different quantities of artificial manures. In one trial the following mixture was used :—

1 part Sulphate of Ammonia,
3½ ,, Superphosphate,
½ ,, Steamed Bone Flour,
1 ,, Sulphate of Potash.

In triplicate plots, 6, 8, 10 and 12 cwt. per acre respectively were sown, the varieties planted being King Edward, Great Scot and Golden Wonder. The weights per acre obtained were :—

King Edward.

Quantity of Mixture.	2 ins.		2 ins. to 1½ ins.		Small.		Diseased.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
0	1	7	3	19	1	11	0	7	7	4
6	3	12	6	12	1	7	0	11	12	2
8	4	14	6	10	1	5	0	12	13	1
10	3	13	6	17	2	0	0	13	13	3
12	3	12	6	14	2	4	0	12	13	2

Great Scot.

Quantity of Mixture.	2 ins.		2 ins. to 1½ ins.		Small.		Diseased.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.	T.	C.
0	7	3	1	7	0	19	0	10	9	19
6	9	6	2	7	0	12	0	19	13	4
8	9	8	2	3	0	13	1	7	13	11
10	9	14	2	10	0	14	0	18	13	16
12	9	11	2	12	0	14	1	11	14	8

Golden Wonder.

Quantity of Mixture.	1¾ ins.		1¾ ins. to 1¼ ins.		Small.		Total.	
	T.	C.	T.	C.	T.	C.	T.	C.
0	1	7	4	3	0	8	5	18
6	4	16	4	19	0	8	10	3
8	4	5	5	15	0	9	10	9
10	4	13	5	15	0	11	10	19
12	4	12	5	6	0	12	10	10

Here, about 8 cwt. of the above mixture in the cases of King Edward and Golden Wonder appears to be about the profitable limit, while possibly a rather larger amount might be profitable in the case of Great Scot.

Other manurial trials carried out with Golden Wonder also indicate that the above amount is quite sufficient.

THE following notes dealing with some practical points in connection with potato virus diseases are contributed by Mr. T. P. M'Intosh, B.Sc., Ph.D.

Potato Virus Diseases.

Plant pathologists of this country are in general agreement concerning the nature of virus diseases of the potato. Intensive research has resulted in the accumulation of a vast amount of accurate information, which is constantly increasing, and there can be no doubt that outstanding problems will ultimately be solved. A considerable period, however, is likely to ensue before the practical application of new principles reaches its full efficiency. At present certain aspects of virus work seem to have been over-emphasised, while other aspects have not been developed as they might have been in the light of existing information. A brief examination of the practical side of this work may therefore be of interest.

Crop Yields.—Some authorities assume that virus diseases are the main causes of the deterioration of potato stocks, and that in the absence of other specific diseases and injuries only virus diseases can influence the potential yielding capacity of potato seed. While the importance of virus diseases should not be under-estimated, other important phenomena must not be excluded from consideration. Physiological causes of variation in the potato crop have not received wide recognition.

Bolters and wildings contribute to the reduction in yield of marketable tubers. A few authorities consider that plants which have assumed these conditions are affected with virus disease; this, however, is extremely doubtful, and grafting experiments which the writer has conducted with genuine bolters and wildings have given entirely negative results. It is quite likely that other explanations, probably physiological, of the above phenomena may soon be found.

The effects of environment on the productive capacity of seed has not, so far as is known, been scientifically tested. This would entail a critical examination of data obtained by the growing in one locality of virus-free seed raised in widely different districts. Nevertheless, it occasionally happens that two or more stocks of the same variety grown on uniformly-treated ground give appreciable differences in yields which cannot be accounted for by any virus disease identifiable by the customary foliage symptoms. It is the writer's opinion, formed after many years of observation in the field, that the vigour of stocks varies according to where the seed is raised and to where the ensuing crop is grown.

The phenomenon of "hide-bound" seed has not been discussed in potato literature. What precisely induces this condition is not definitely known, but storage in a warm, dry atmosphere would appear to be the most probable cause; indeed, "hide-bound" seed is most frequently found where house storage has been practised. Affected tubers sprout very slowly, the plants grown from them and the yields are small and the parent sett seldom decays. Derivative tubers, however, if normally stored, give rise to normal plants in the succeeding year. The condition has been recognised in Scotland and Germany, and whereas in degree it may be extreme, there can be no doubt that it affords an illustration of a definite physiological cause of crop depression. Premature tuber formation, or "Little Potato," which, however, is more common on the Continent than in Britain, is another example of crop reduction which has frequently a physiological explanation.

New Varieties.—There is a tendency at present for potato raisers to isolate seedlings in the early stages and to submit for registration trials stocks which are comparatively free from diseases. In some cases this may perhaps give rise to a belief that absence of diseases implies resistance to their spread. Nothing could be more erroneous, as experience with new introductions has so often demonstrated. Glasshouse tests at most determine only whether any particular variety is "tolerant" of a specific virus disease, i.e. the nature of the damage done to the plant. Such tests cannot determine how rapidly virus diseases will spread in a stock nor the precise effect of such diseases on yields. An example will make this clear. In glasshouses every variety can be equally well infected, by graft or *Myzus persicæ*, with leaf-roll, yet in the field this disease will spread many times more rapidly in some varieties than in others. The rapidity of spread in the field probably depends upon the affinity of the plant as a host to the carrier. The necessity therefore of subjecting new varieties to a well-planned field test to determine their resistance to the natural spread of virus diseases and the effects of the latter on yields will be appreciated by growers who occasionally expend large sums for stocks of new varieties in the hope that first-class material has at length appeared.

Further Applications of Existing Information.—The following practical considerations may be of value :—

1. All virus diseases appear to be capable of transmission by foliage grafts. The determination of the purity of certain potato varieties has always occasioned difficulty because of the existence of types probably pathological in origin but sufficiently atypical to create doubt as to whether or not they are distinct varieties. This is particularly true of Di Vernon, and it is suggested that reciprocal grafts would materially assist in solving such problems. Further, grafting might help in cases where diseases were not suspected. There are in some varieties

healthy plants which in points of detail differ from the varietal types, e.g. the green-budded Kerr's Pink and the " rogue " in Arran Chief. Since no two varieties appear to react similarly to all common virus diseases, it may be possible by grafting to determine whether these types belong to the varieties in which they are found.

2. If virus diseases are spread mainly by means of aphids, and if infection is carried by these insects for some considerable distance, it will be abundantly clear that stocks which carry much infection should not be planted in the immediate neighbourhood of stocks comparatively free of disease. This consideration applies also where the infected stock is a " carrier " and not itself seriously damaged by the disease. As it is quite common to find many different varieties, including badly mosaiced Golden Wonder and Arran Chief, in a field, it may now be opportune to collate information concerning the behaviour and health of all common varieties, to formulate a cultivation policy, and to conduct propaganda to ensure that the spread of virus diseases in this way is reduced to a minimum.

3. All host plants of aphids should be destroyed so far as possible. Those whose duty it is to advise growers as to the best methods of producing healthy potato stocks should emphasise that no crop responds more readily to clean culture.

Present Day Use of Whins for Cattle Food.

PROFESSOR JAMES RITCHIE of the National History Department, University of Aberdeen, author of the illustrated article on *Whin Bruisers and Whin Mills in former days in Scotland*, which appeared in the October number of the JOURNAL, has received the following interesting account from Kilkenny of the use of whins as forage in Ireland at the present day.

The writer, Mr. Timothy Lucey, was struck by the clumsiness of the Scottish implements for the use to which they were put, and describes the Irish method of chopping the whins with an ordinary chaff-cutter. Obviously he refers to a period later than the origin of the Scottish whin-mills. In the course of an interesting letter he says :—

" On hillside farms in the south of Ireland, whins, or ' French furze ' as it is called there, where hay is scarce and usually a poor crop, is fed to horses during the winter months, a simpler and at least sufficiently effective process is resorted for pulverisation; it is run through an ordinary chaff-cutter. A piece of ground is sown with the seed and cut biennially; grown in this way it is more tender than when grown in the open. In chaffing, a little hay is sometimes added, and for young horses during dentition changes the finer cut is used to admit of easier mastication. It is not, however, regarded as possessed of any medicinal properties, and does not rid horses of worms, but has a tendency to keep them in sleeker and apparently better condition than when fed on hay alone during periods when they are not working. The labour of chaffing, &c. does not admit of its extension beyond the smaller farms where the work is all done by the family. Before the introduction of roots it was, I understand, used as a forage for early calved cows, being chaffed fine and saturated with a thin gruel of crushed oats, or maize meal, boiling hot. This is now seldom resorted to, except by cottars with one or two cows, who, if not possessed of a chaff-cutter, bruise it in a trough, not using a mallet as you describe, a knife weighted at the end of a spade-handle being used instead. It, however, needs to be fed with caution, as cattle get blown, and if it is fed to incalf cows in times of extreme scarcity of hay, there may be trouble at calving time owing to the size of the calf."

Labour on Scottish Farms.

THE Agricultural Returns collected on 4th June 1930 give the following numbers of workers employed on that date on holdings exceeding one acre in extent. The occupiers of holdings, their wives and domestic servants are excluded, but working members of the occupiers' families other than their wives are included.

	Regular Workers.	*Casual Workers.*
Males, 21 years old and over ...	60,037	6,023
Do. under 21 years old ...	20,678	2,972
Total of males	80,715	8,995
Women and girls	18,582	7,216
Total	99,297	16,211
Grand Total ...	115,508	

The grand total is 2,526 below that recorded in 1929, regular workers being fewer by 1,786 and casual workers by 740. Of the regular workers, men over 21 have decreased by 566 and males under 21 by 793. The proportional decrease among the latter is about four times that among the former. The total decrease in the number of regular male workers is 1,359 or 1·7 per cent.

Women and girls regularly employed have decreased by 427, male casual workers by 526, and female casual workers by 214.

The International Yearbook of Agricultural Statistics.

THE International Institute of Agriculture has recently published the 1929-30 edition of *The International Yearbook of Agricultural Statistics.*

In the first part of the Yearbook are classified the figures for area and population in the years nearest to 1913 and 1929 for 220 countries. The second part is composed of a series of tables comprising for nearly 50 countries the available data concerning the uses for which the total area is employed, the apportionment of cultivated areas between the different crops, agricultural production, numbers of the different kinds of live stock and the products derived from them. The tables constituting the third part of the volume show for nearly 40 agricultural products the area, production and yield per acre in each country during the last five years of the pre-war period and during each of the years from 1926 to 1929.

For each kind of live stock, all available figures in the different countries have been grouped for the years 1913 and 1925 to 1929. A large part of the volume is devoted to statistics of the commercial movement of 42 vegetable products and 12 products of animal origin. The figures published relate to the imports and exports during the calendar years and for the cereals also during the commercial seasons.

The part devoted to prices contains the weekly quotations of 25 agricultural products on the principal world markets for the year 1913 and for the period January 1926 to June 1930. In the freights section will be found the quotations for the carriage of wheat, maize and rice on the most important shipping routes, and in the section reserved for fertilisers, and chemical products useful in agriculture, are published statistics of production, trade and prices for 15 products. In the rates of exchange section are set out the rates on the New York Exchange for the most important currencies.

A new feature is the section containing special chapters on the importance and distribution of the agricultural population, the distribution of agricultural holdings according to their size and mode of tenure, and forestry.

Copies may be purchased from Messrs. P. S. King & Son, Ltd., 2 and 4 Great Smith Street, London, S.W.1, price 25*s.* post free.

Acreage under each Variety of Potatoes in 1930.

A STATEMENT is printed on p. 115 showing the acreages under certain varieties of potatoes in Scotland in 1930, as returned by growers of one acre or over. These returns cover 105,435 acres out of the total area of 123,358 acres, the difference being principally accounted for by the total exclusion of certain districts in the Highlands and Western Islands, and by the exclusion of holdings on which less than one acre is grown. The total acreage shows a decrease of 21,412 acres as compared with 1929, and the acreage included in the returns of varieties a decrease of 21,537 acres.

The area under First Earlies, 13,120 acres, is less by 2,024 acres, or 13·4 per cent., than that returned in 1929. Epicure, with 7,703 acres, or 236 acres less than last year, accounts for 58½ per cent. of the total. Duke of York, with 1,794 acres, shows a decrease of 614 acres, or 25·5 per cent., and, as last year, takes second place, while Sharpe's Express, with 1,712 acres, has also decreased by 242 acres, or nearly 13 per cent., and still occupies the third place. Eclipse, which formerly had the second largest acreage, is now, as in 1929, fourth with 948 acres, a decrease of 846 acres, or 47 per cent. These four varieties cover 92½ per cent. of the whole area under First Earlies. Herald, the new immune variety, has decreased from 132 to 77 acres.

Second Earlies, with a total acreage of 15,362, fall below that recorded in 1929 by 5,188 acres. Great Scot, with a decrease of 3,718 acres, covers 10,059 acres. British Queen, with 3,518 acres, shows a very small decrease, while Ally, with 339 acres, is less by 623 acres, or 64·8 per cent., and is slightly in excess of Arran Comrade, which has an acreage of 331. These four varieties account for 92·7 per cent. of the total area.

The area under Maincrops, 76,953 acres, shows a decrease of 14,325 acres. Kerr's Pink, with 39,097 acres, still holds first place and covers 51 per cent. of the whole area, but as compared with last year it has lost 8,232 acres, or 17·4 per cent. The second place is retained by King Edward VII with 15,146 acres; this is only 178 acres under last year's figure. Golden Wonder, Majestic and Arran Chief follow with 7,986 acres, 5,657 acres and 3,035 acres respectively, the first showing an increase of 1,270 acres and the other two decreases of 1,880 acres and 2,777 acres. These five varieties account for 92 per cent. of the maincrop acreage. The Up-to-Date group shows a decrease of 462 acres, but the new variety, Arran Banner, has increased to almost three times last year's acreage. Arran Consul shows a further reduction from 1,610 acres to 617 acres. All other varieties except Irish Queen show a diminished acreage, Tinwald Perfection and Rhoderick Dhu being reduced by nearly two-thirds.

Varieties immune from wart disease cover in all 68,418 acres, or 64·9 per cent. of the total area included in the return; non-immune varieties cover 36,346 acres, or 34·5 per cent.; while the varieties not specified in the returns account for only 671 acres, or less than 1 per cent. The percentage of immune varieties is less than last year by 0·5, and that of non-immunes greater by the same amount. This is the first occasion in which the immune varieties have failed to show an increased percentage since the returns were first taken in 1918.

Annual Estimates of the Produce of Crops. THE following statement regarding the produce of crops for 1930 was issued on 15th December:—

Preliminary Statement showing the ESTIMATED TOTAL PRODUCE and YIELD PER ACRE of Wheat, Barley, Oats, Beans, Hay, Potatoes and Roots, in SCOTLAND in the Year 1930, with

COMPARISONS for 1929, and the AVERAGE YIELD PER ACRE of the Ten Years 1920-29.

CROPS.	Estimated Total Produce.		Acreage.		Average Estimated Yield per Acre.		Average of the Ten Years 1920-1929.
	1930.	1929.	1930.	1929.	1930.	1929.	
Wheat ...	*Tons.* 57,000 *Quarters.* 264,000	*Tons.* 58,000 *Quarters.* 263,000	*Acres.* 53,927	*Acres.* 50,730	*Cwt.* 21·0 *Bushels.* 39·1	*Cwt.* 22·9 *Bushels.* 41·5	*Cwt.* 21·2 *Bushels.* 38·8
Barley (including Bere) ...	*Tons.* 95,000 *Quarters.* 502,000	*Tons.* 101,000 *Quarters.* 521,000	106,571	100,549	*Cwt.* 17·8 *Bushels.* 37·7	*Cwt.* 20·1 *Bushels* 41·5	*Cwt.* 17·8 *Bushels.* 37·1
Oats ...	*Tons* 647,000 *Quarters.* 4,477,000	*Tons.* 755,000 *Quarters.* 5,058,000	861,712	888,731	*Cwt.* 15·0 *Bushels.* 41·6	*Cwt.* 17·0 *Bushels.* 45·5	*Cwt.* 14·9 *Bushels.* 40·8
Beans ...	*Tons.* 3,400 *Quarters.* 15,500	*Tons.* 2,700 *Quarters.* 12,300	3,356	2,833	*Cwt.* 20·0 *Bushels.* 36·8	*Cwt.* 19·3 *Bushels.* 34·7	*Cwt.* 18·1 *Bushels.* 33·1
Hay from Rotation Grass	*Tons.* 651,000	*Tons.* 681,000	410,491	408,322	*Cwt.* 31·7	*Cwt.* 33·3	*Cwt.* 32·3
Hay from Permanent Grass ...	160,000	157,000	122,113	120,032	26·3	26·2	26·5
Hay from Timothy Meadows ...	108,000	112,000	48,597	47,836	44·6	47·0	43·5
Potatoes	860,000	1,155,000	123,358	144,770	*Tons.* 7·0	*Tons.* 8·0	*Tons.* 6·8
Turnips & Swedes	5,822,000	6,606,000	372,696	371,273	15·6	17·8	17·1
Mangolds ...	24,500	24,800	1,181	1,204	20·8	20·6	18·2

NOTE.—The total produce of Wheat, 57,000 tons, is 1,000 tons less than that of 1929. The area under the crop was greater by over 3,000 acres, but the average yield per acre, 21·0 cwt., is 1·9 cwt. under last year's figure, and 0·2 cwt. below the ten years' average. Barley, with a total produce of 95,000 tons, shows a decrease of 6,000 tons. The area harvested is more than that of 1929 by 6,022 acres, but the average yield per acre, 17·8 cwt., is 2·3 cwt. less than in the preceding year. The total produce of oats, 647,000 tons, is less than in 1929 by 108,000 tons. The area shows a decrease of 27,019 acres, and the average yield per acre, 15 cwt., is lower than that of the preceding year by 2 cwt. The total produce of Beans amounts to 3,400 tons, or 700 more than in 1929; the average yield per acre is almost 2 cwt. above the ten years' average.

The total produce of Hay of all kinds, 919,000 tons, is 31,000 tons below last year's total. Hay from rotation grass, with a total production of 651,000 tons, accounts for 30,000 tons of this decrease. The area is larger than in 1929 by over 2,000 acres, but the yield per acre, 31·7 cwt., is 1·6 cwt. below that in the preceding year, and is 0·6 cwt. below the ten years' average. Timothy meadows, with an average yield of 44·6 cwt., produced 108,000 tons, or 4,000 tons less than last year, while other meadows, with an average yield of 26·3 cwt., produced 160,000 tons, exceeding last year's crop by 3,000 tons.

The outstanding feature of the returns is the great decrease in the production of Potatoes, the total being 860,000 tons as compared with 1,155,000 tons in 1929. The diminution is thus 295,000 tons, or over 25 per cent. This is accounted for by a decrease of 21,400 acres in the area under the crop, which was this year the smallest recorded since 1897, and a decrease of one ton in the yield per acre, which is 7 tons as compared with 8 tons in 1929. Although considerably below the record figures of last year, the yield per acre exceeds the ten years' average by 0·2 ton. Turnips and Swedes, with a total produce of 5,822,000 tons, shows a decrease of 784,000 tons. The area was greater than in 1929 by 1,423 acres, but the yield per acre, 15·6 tons, is 2·2 tons below that of 1929, and 1·5 tons below the ten years' average. The total produce of Mangolds, 24,500 tons, is 300 tons below that of last year; the high yield per acre obtained last year was slightly exceeded.

All the crops except beans, mangolds, and hay from permanent grass, show a reduction in the yield per acre as compared with the high yields of 1929, but only for wheat, turnips, hay from rotation grass and from permanent grass do the yields compare unfavourably with the ten years' average. The total produce of all crops except beans is smaller than that in 1929.

Agricultural Returns, 1930.

THE abstract of the Agricultural Returns printed on pp. 116-123 shows that the total area under all crops and grass amounts to 4,640,718 acres, a net decrease of 12,270 acres as compared with 1929, the arable land being less by 33,663 acres, while the area under permanent grass is greater by 21,393 acres. The area under rye-grass and other rotation grasses and clover has diminished by 468 acres, the decrease in the area under other crops being thus 33,195 acres.

The total area under the cereal crops is 1,026,381 acres, being 17,631 acres less than in 1929. The acreage under wheat is greater by 3,197 acres or 6·3 per cent., and that under barley by 6,022 acres or 6·0 per cent., but the area under oats is less by 27,019 acres or 3·0 per cent.

Beans show an increase of 523 acres or 18·5 per cent. Potatoes have decreased by 21,412 acres or 14·8 per cent., while turnips and swedes have increased by 1,423 acres or 0·4 per cent. The area under mangolds is less by 23 acres or 1·9 per cent. The acreage under sugar beet has risen to 1,663 acres this year, an increase of 1,050 acres or 171·3 per cent. Cabbage shows an increase of 602 acres or 14·6 per cent., and rape 1,836 acres or 20·8 per cent., while the area under flax this year is 72 acres as against 3 acres and 1 acre in 1928 and 1929 respectively. The greater part of this acreage has been returned in the counties of Fife and Perth. Vetches, tares, &c. for fodder have decreased by 268 acres or 2·4 per cent.

Rye-grass and other rotation grasses and clover show a net decrease of 468 acres or 0·03 per cent., the area for hay being greater by 2,169 acres or 0·5 per cent., but that for pasture being less by 2,637 acres or 0·2 per cent. The area under permanent grass shows an increase of 21,393 acres or 1·4 per cent., the acreage for hay being greater by 2,842 acres or 1·7 per cent., and that for pasture by 18,551 acres or 1·3 per cent.

The area under wheat, barley, oats and potatoes, 1,145,568 acres, is 39,212 acres less than last year, and is the lowest aggregate recorded.

The live stock returns show that cattle, sheep and pigs have increased while horses have decreased. Horses used for agricultural purposes are less numerous by 3,126 and unbroken horses of one year and above by 391, but those under one year have increased by 96. " Other horses " show a diminution of 1,268, the net decrease for all classes being thus 4,689 or 2·9 per cent. Cows in milk are fewer by 4,850 or 1·4 per cent., but cows in calf have increased by 124 or 0·3 per cent., heifers in calf by 4,042 or 7·9 per cent., and bulls by 156 or 0·9 per cent. Other cattle, two years and above, have increased by 1,184 or 0·5 per cent., and those of one year and under two by 3,368 or 1·1 per cent., but those under one year are less by 970 or 0·4 per cent. The total number of cattle has thus increased by 3,054 or 0·2 per cent. The total number of sheep show an increase of 94,031 or 1·2 per cent., the total, 7,649,551 being the highest on record. All classes of sheep, with the exception of other sheep, one year and above, show increases. Breeding ewes have increased by 44,147 or 1·3 per cent., and rams by 1,788 or 2·0 per cent. Other sheep, one year and above, have decreased by 5,145 or 0·5 per cent., but those under one year have increased by 53,241 or 1·7 per cent. The number of pigs, 143,269, is greater than in 1929 by 1,052 or 0·7 per cent. Sows have increased by 1,770 or 11·0 per cent., but boars have decreased by 39 or 2·2 per cent. and other pigs by 679 or 0·5 per cent.

The acreage under rough grazings, 9,500,576 acres, is less than last year by 72,538 acres. This acreage includes 375,725 acres of deer forest land used for grazing which was formerly returned by sheep farmers as rough grazings, but which, on investigation, has been found to be actually deer forest land made available for grazing. The total figures for cattle and sheep in Scotland include 3,030 cattle and 92,188 sheep grazing in deer forests on 4th June. Of these 1,152 cattle and 55,426 sheep were also included in returns made by agricultural occupiers, and these particulars have been cancelled as duplications on Agricultural Returns and are now brought under the heading of deer forest stock. The remaining 1,878 cattle and 36,762 sheep were not included in any Agricultural Returns, and represent the stock pertaining to deer forests as such.

The returns include statistics of acreage owned by occupiers of holdings and particulars relating to poultry. These particulars are not included in the printed abstract.

The total area of land under crops and grass returned as owned by occupiers of holdings in 1930 amounts to 1,410,619 acres as compared with 1,350,091 acres in 1929, an increase of 60,528 acres. This area is 30·4 per cent. of the whole area of land under crops and grass; in 1929 the proportion was 29·0 per cent.

The poultry figures are as follows :—

Fowls hatched before 1930	2,766,942
Fowls hatched this year	3,550,483
Ducks hatched before 1930	135,519
Ducks hatched this year	90,087
Geese hatched before 1930	7,104
Geese hatched this year	16,030
Turkeys hatched before 1930	18,133
Turkeys hatched this year	79,928

The returns of labour employed on farms are summarised at page 89.

Agricultural Conditions in 1930.

Weather.—During January the weather was generally mild and open in the north-eastern and most of the northern counties, with occasional high winds and some rain; there were some short spells of frost, but practically no snow. In the eastern and south-eastern districts conditions were also generally favourable, but elsewhere the weather was very wet and arrears of ploughing accumulated. February was generally dry and frosty, with practically no rain and comparatively little snow, except in parts of Perth and Angus, where there were heavy falls. The weather at the beginning of March was generally open and seasonable, but towards the middle of the month ploughing and sowing were interrupted in several areas by severe frost and heavy falls of snow; over the greater part of the country the rainfall during the month was unusually light, but in Skye and Lewis rain was frequent. During April the conditions showed *considerable variation; in Shetland and the north-eastern districts cold wet weather prevailed throughout the greater part* of the month, but conditions were favourable in the south-eastern areas, while along the western seaboard the weather was cold and dry. The weather during May was mainly dry in most areas, but during the first fortnight a considerable amount of rain fell in a few northern districts and in the Western Islands. In June and the first fortnight of July the weather was mostly dry and sunny, and the growth of crops was checked to some extent on light land owing to lack of moisture. During the remainder of July wet and unsettled weather retarded the hay harvest and caused damage to the hay crop in a few districts; lodging of cereal crops was also reported from some areas. In the Western Islands and Orkney the weather was suitable for crops throughout the month. During August the weather was very broken; heavy rain was frequent and there was comparatively little sunshine. Grain, particularly oats, was laid and twisted in many districts. The only areas from which favourable reports were received were Harris and Uist. Throughout the greater part of September there were exceptionally heavy rainfalls in most parts of the country, and there was a marked absence of drying winds. More or less serious damage was done to all cereal crops, especially along the eastern seaboard; in the reports received from a number of eastern districts September is stated to have been one of the worst harvesting months on record. Flooding occurred in many north-eastern areas, and quantities of grain sprouted in the stooks. The outstanding feature of the reports for September was the excellent harvest weather that prevailed in the Outer Hebrides and to a less extent in Skye. The weather throughout October was wet in most districts, especially during the earlier part of the month, and harvesting generally was more or less seriously impeded; there was an almost entire absence of frost, but along the western seaboard the weather was mostly cold, wet and stormy. The water-logged condition of the soil made potato lifting a tedious and difficult operation in most parts of the country.

Wheat.—The winter sowing of wheat was completed in most districts early in December, and by the end of the year a strong and regular braird was showing on many fields. The open weather of January favoured the crop, and good progress was generally made throughout February, despite the frost. The reports received during March were somewhat variable, but growth improved thereafter, and by the end of June the crop was healthy and vigorous in most districts; in South-East Perth, however, many fields were badly thinned by wireworm. In a number of areas the crop was more or less lodged during August and some sprouting took place, but generally it was well ripened by the end of the month. Cutting was then in progress in several north-eastern and south-eastern districts, but was not general until early in September; the harvest was not completed, however, until about the middle of October, and in most districts the grain showed considerable deterioration as a result of the exceptionally unfavourable weather conditions that prevailed during September.

Barley.—Sowing was somewhat later than usual, being retarded by frost and subsequently by wet weather in a number of areas; the crop made steady progress, however, and by the end of May was generally healthy and vigorous, although growth was retarded to some extent by cold dry winds. Charlock was unusually prevalent in Berwick. In several north-eastern areas the crop, where sown late or on dry land, suffered from drought in June. At the end of August the plants were generally reported to be healthy, but in many areas, particularly in the north-eastern counties, the crop was badly lodged and twisted by heavy rains during the latter part of July and in August. A good beginning was made with cutting by the end of August in most districts, but harvest was not completed until the fourth week of October; the grain was generally below the average in quality, and sprouting in the stooks took place to a greater or less extent. The reports on bere were generally satisfactory; cutting was in progress at the end of August in most districts where this crop is grown, and the yield proved to be fully average.

Oats.—Sowing was generally completed before the beginning of May, except in Skye and the Outer Hebrides. Germination was slow, but the braird in most districts was strong and regular. Up to the beginning of June the crop had not been attacked by grub to the same extent as in 1929, but as the season advanced much damage from this cause was reported from Berwick, Caithness and Sutherland, while in parts of South-East Perth many fields were practically ruined by wireworm. Charlock was prevalent in Berwick and in some parts of Dumfries. The heavy rains in August were detrimental to the crop, which was generally badly lodged and twisted, except in the Western Islands and in a few south-western districts; second growth was prevalent in a number of isolated areas. Harvest was in progress in most districts at the end of August, but proved difficult on many farms, and even at the end of October the work had not been completed on higher ground in South-West Perth and in Berwick. The quality and condition of the crop was satisfactory in Shetland, the Outer Hebrides and several south-western districts, but in most of the remaining areas the crop was more or less seriously damaged, much of the grain being soft and discoloured.

Beans.—In most of the districts in which this crop is grown sowing was completed or practically completed by the end of March. The crop made steady progress despite the somewhat dry weather during May and part of June; in most districts the plants podded well, and on the whole the crop was healthy and vigorous. A full average yield was obtained, except in Berwick and South Ayr, where it was somewhat below the normal.

Potatoes.—The planting of first and second earlies was practically completed in South Ayr and Dumfries by the end of March, and in Wigtown about a third of the main crop was planted during that month, but in most districts there was still a considerable proportion of the area to be planted at the end of April; in South-West Aberdeen the work had not then begun owing to cold, wet weather. In practically every district planting was completed before the end of May in very favourable conditions as regards both soil and weather. Where the crop was showing above the ground at that time the haulms were generally strong and vigorous. More rain was required in a few districts at the end of June. The crop generally made good progress during July and August, especially along the western seaboard, but towards the end of the latter month blight was more or less prevalent in many north-eastern areas, especially among the earlier varieties, and was also in evidence in a few south-western districts. During September the crop suffered a setback as a result of heavy rains and absence of sunshine, and blight became fairly general. The most satisfactory reports were those received from the Western Islands, where the crop was on the whole in very good condition; in most of the south-western districts, also, it was generally healthy. In most districts three-quarters or more of the crop had been lifted at the end of October, despite the generally adverse weather conditions. The estimates of yield showed considerable variation.

Turnips and Swedes.—The sowing of root crops was generally well advanced by the end of May. In most districts the sowing of swedes was practically completed at that time, but progress with the sowing of yellow turnips was much slower; at the end of May sowing of the latter had not commenced in Caithness. Owing to the exceptionally dry weather in the early summer a considerable amount of re-sowing proved necessary in a number of districts, and in several instances second re-sowings had to be made. Fly was prevalent in parts of North-East Aberdeen, Berwick, Inverness, Nairn and Dumbarton, and in South-West Angus, where spurrey was also troublesome, some fields were attacked by the turnip flea beetle; much damage was caused by pigeons in Central Perth. As the season advanced the reports showed considerable variation; in most of the north-eastern districts finger-and-toe, and to a lesser extent canker, were more or less prevalent. Weeds proved unusually troublesome in several south-western areas. Over the season, swedes appeared to have made relatively better progress than turnips.

Mangolds were sown in good time and made steady progress throughout the season, despite the unusual lack of sunshine; in most of the districts where this crop is grown the yield was a good average.

Sugar Beet.—The acreage shows an increase of no less than 171 per cent., the figure being 1,663 acres, as compared with 613 last year. The crop made satisfactory progress throughout the season in most districts.

"Seeds" and Meadow Hay.—The reports on grass and clover seeds received in February indicated that the crop was then for the most part vigorous and healthy, although in most districts there was little or no growth during the month. In April the condition of the crop was still satisfactory, but growth had been checked by cold winds and frost in some districts, especially Caithness, Harris and Uist. Progress was rather slow during May owing to the low rainfall, and in Berwick, Roxburgh and Selkirk the plants where grazed were somewhat thin on the ground. Good progress was made with the harvest in a few south-western districts during June, some early fields being secured by the end of the month, and in a number of eastern and south-eastern areas cutting had begun at that time; in most of the northern and north-eastern districts, however, the work had not commenced at the end of June. Clover proved to be less abundant than usual in a number of districts. Cutting was completed in only a few areas before the end of July, the work having been retarded and in some instances brought to a standstill by the adverse weather conditions towards the end of the month. The estimates of yield for seeds hay were disappointing in practically every district; in most areas the figure was put at from 5 to 10 per cent. below the normal. The reports regarding meadow hay were relatively slightly better; in about half the districts reported on an average crop was estimated, but in the remainder the yield was more or less below the normal.

Cultivation.—Fair progress with ploughing and manuring had been made by the beginning of November in most north-eastern and south-eastern districts, but in Shetland, Orkney, the northern counties and along the western seaboard very little cultivation had generally been done at that time. By the end of November the work was well forward in Fife and most of the south-eastern districts, and fair progress had also been made in Sutherland, Ross and Cromarty, and a few north-eastern areas; in most other districts, however, cultivation was more or less in arrear at that time owing to unfavourable weather and the wet state of the ground. Wheat sowing was completed or practically completed by the end of November in Angus, Perth, Fife, Kinross, Clackmannan, the Lothians, Roxburgh and North-West Lanark; elsewhere, however, only fair progress had been made at that time. At the beginning of December the braird was showing on early-sown fields in Central Perth.

Live Stock.—Pastures were generally in satisfactory condition throughout the grazing season, although somewhat soft in some districts towards the end. Grazing cattle throve well throughout the season in most districts; in several north-eastern areas their condition was adversely affected by the wet weather during August, and in the late autumn the report from North Ayr indicated that their condition was poor. Dairy cattle generally made good progress throughout the season, but during August considerable loss occurred among calving cows in Dumbarton owing to mammitis (" weed "). The milk yield was well maintained in most districts. In November, apart from the normal seasonal falling off, the supply was below the average for the season in Kincardine, South-East Perth and South-East Lanark. The reports on sheep were generally satisfactory, but maggots were more or less troublesome throughout the season in several north-eastern and eastern districts; in some eastern counties, and in Dumbarton and Kirkcudbright, foot rot was also in evidence from time to time. In Central Perth and in Berwick the death-rate among hoggs was reported to be higher than usual during November. Supplies of winter keep are generally satisfactory, but in Shetland and in several north-eastern districts there is a certain scarcity of turnips.

Labour.—The supply of regular workers was generally adequate for requirements, except in South-West Perth, where skilled workers were somewhat scarce throughout the season; there was also a certain scarcity of casual labour for harvesting and potato lifting in a number of districts. In Dumbarton, Renfrew and North Ayr the supply of experienced women dairy workers was short of requirements towards the end of the year.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

The Yield of Sharply Contrasting Pasture Types and their Response to Manures. *By R. G. Stapledon, M.A., and M. T. Thomas, B.Sc., Welsh Plant Breeding Station, Bulletin, Series H, No.* 11, *Seasons* 1921-1929.—Amongst the conclusions drawn from the trials by the authors are the following :—

Good temporary leys sown with indigenous species show a high yielding ability when compared with really good permanent pastures on relatively similar soil types.

The all the-year round yields of upland pastures are poor compared with those of lowland pastures.

Nitrogen under drastic defoliation greatly reduces the contribution made by wild white clover to the total eatables offering, and this reacts adversely on the mid season yield of swards to which this clover is a heavy contributor.

This fact points to the necessity of regulating very carefully the grazing on areas treated with added nitrogen so as to maintain a proper balance between grasses and clovers.

The upland pastures have responded relatively better than the lowland to phosphates, potash and nitrogen.

These trials have shown how very amenable upland swards are to treatment, and tend rather to suggest that the improvement of hill grazings may well be a comparatively easy and in many cases an entirely economic proposition.

Potato Breeding Methods: II. Selection in Inbred Lines. *By F. A. Krantz and A. E. Hutchins, University of Minnesota, Technical Bulletin,* 58, *April* 1929.—It is stated that the amount of breeding work on potatoes in progress in America is much less than that carried out in the case of other important food crops, and that this neglect exists in spite of serious defects in the important commercial potato varieties.

The tubers of Bliss Triumph are red in colour, the variety is limited in climatic adaptability, and it is also very susceptible to virus diseases. Irish Cobbler has tubers with deep eyes which incur much waste in utilisation. In early Ohio knobs are frequently formed and growth cracks occur on the tubers when growing conditions vary slightly throughout the season.

In 1921 work was started with a view to producing a higher yielding commercial variety by applying the principle of "selection in self-fertilised lines" to a vegetatively propagated crop. During the progress of this work approximately 40,000 seedlings were grown, but in the experiments reported only a small proportion of these have been directly utilised. The method followed in these experiments is to inbreed continuously until individual plants are secured that breed true for their important characters. The best plants in each generation are used as parents for the succeeding generation. The usefulness of individual plants depends not upon their own performance but upon their breeding value as ascertained by a study of their progeny, and upon their ability when crossed to produce plants of economic value. The necessity of obtaining such plants for breeding purposes is due to the heterozygous character of potato varieties. They are extremely variable and often contain recessive factors for undesirable characters. Selection in self-fertilised lines offers the best means of eliminating the undesirable characters, and the potato is particularly well adapted to this method of breeding.

The general effect of inbreeding on the potato is first to expose the heterozygous condition of a potato variety. The variability of the first generation progeny is very marked. In the third generation more stable breeding lines are noticeable. The data show that there is a general tendency for vigour to be reduced by inbreeding.

In selecting for earliness late-maturing seedlings can be safely discarded, while the early-maturing seedlings should be further sorted out on the basis of breeding behaviour. The method used to obtain early-breeding stocks was to cross selected fertile seedlings and the early seedlings of varieties, and again selected in the inbred lines obtained from the F_1 progeny. Seedlings lines have been obtained by this method that compare favourably in early maturity with the progeny of the early varieties, and, in addition, have the fertility required in breeding stock.

The failure to set fruit because of pollen abortion has been overcome by inbreeding partially fertile varieties, and by crossing sterile and weak pollen-producing varieties with fertile seedlings and then inbreeding the first generation. Most of the important economical characters are fairly easy to fix in the inbred lines. The results obtained from crosses between varieties and between inbred seedlings show that the loss in yield occasioned by inbreeding can be regained and in many cases reduced by appropriate recombinations.

FERTILISERS.

Essential Plant Food Elements. *By Oswald Schreiner, American Potato Journal, November* 1930.—Dr. Schreiner discusses some of the new factors in fertiliser practice relating to the influence of the lesser known elements on plant growth and production. Researches have shown that magnesium, iron, sulphur and manganese deficiencies can exist in comparatively large soil areas. The use of manganese has increased in recent years as a result of demonstrations with tomatoes in Southern Florida. Investigation of the failure of tomato crops revealed a manganese deficiency, and an application of 50 lb. of manganese sulphate per acre produced strong vigorous plants and a greatly increased fruit production. Samuel and Piper of the University of Adelaide have also demonstrated the essential character of this element. They have shown that a disease of oats occurring in South Australia and also in Germany and Sweden on alkaline soils is due to lack of available manganese in the soil. The element boron has also been shown to be essential to plant development and crop production. The exact part played by boron is obscure. In boron-deficient tomato plants, starch and sugar were more abundant in the leaves and stems than in the corresponding tissues of normal plants. Potatoes grown in boron-free culture showed a high starch content of the leaves, and also the characteristic symptoms of the potato leaf roll disease. All these abnormal symptoms were obviated by adding as little as half a part per million to the culture solution. Toxicity was reached with as little as five parts per million. Considerably more information will have to be available before these rarer plant food elements can be safely used as fertilisers, but it seems more than probable that the greater use of more highly concentrated pure fertilising materials may lead to a depletion of these minor elements in soils, and it may be that manure manufacturers may have to consider the introduction of these rarer elements into fertiliser mixtures.

DAIRYING.

Modern Dairy Methods. *Science, Nov.* 11, 1930.—An ingenious device called the "rotolactor," which is designed to economise labour and to procure a high grade milk, has recently been installed at the dairy farm of the Walker Gordon Laboratories, Plainsboro, New Jersey. Under this system the cow barns become living and dining quarters exclusively, and milking is done mechanically under the most hygienic conditions in a tiled "rotolactor" room which is fed with conditioned air. The rotolactor itself is a circular platform 60 feet in diameter and is provided with 50 stalls arranged radially. The cows to be milked are brought from the barns in single file along leading gangways to the edge of the rotolactor. Each cow in turn steps into a stall on the slowly moving platform and is automatically secured. As the platform rotates the cow receives an automatic warm shower bath, while above her the milking machine and milk receiver of her stall are being cleaned and sterilized by machinery. The cow then receives the attention of an attendant whose sole duty consists of drying the udders with individually sterilized towels. The cow is then inspected by an expert hand milker who withdraws the fore-milk and starts up the machine. Just 12½ minutes after the cow steps on to the milking merry-go-round the milking is complete and the cow is automatically released to walk back to the barn. In an eight hour day of continuous operation the rotolactor will milk 1,800 cows three times daily.

A Study of the Bacterial Count of the Fore-Milk of Cows. *J. Faber, Jour. Dairy Science*, 13, 449-452.—The first drawn milk from each teat of the milking cow usually contains much larger bacterial numbers than the later drawn milk. Consequently in hygienic milk production such milk ought to be discarded. In order to determine just how much should be rejected the author carried out a long series of tests on previously cleaned cows, and made counts of the bacteria in successive streams. He finds that the first stream is most grossly contaminated, containing on an average 1,275 bacteria per c.c.; the fifth stream contains on an average 551 per c.c.; the eleventh stream contains 449 per c.c. From a practical standpoint, the author concludes that as there is little reduction in bacterial numbers beyond the fifth stream, only five streams from each teat need be discarded.

Effect of the Electropure Process on Bacterial Spores in Milk. *Gelpi and Devereux, Jour. Dairy Science*, 13, 368-371.—It is well known that pasteurisation does not destroy all forms of bacterial life in milk. The spores of certain bacteria can easily survive the heating process, and if they be of a nuisible type the treated milk will be less suitable for consumption and manufacturing purposes than milk in which such spores do not occur. In recent years the Electropure process, which essentially consists in passing a current of electricity through the milk as it flows through a special chamber, has attracted considerable attention in virtue of the fact that it effects a marked reduction (approximately 99 per cent.) in the bacteria originally present in the milk. The author of this article shows that the Electropure process is highly efficient in destroying not only the ordinary vegetative forms of bacteria but also spores, and that in the latter respect it is superior to the holding method of pasteurisation.

ANIMAL BREEDING.

Cattle.

Future of Beef Production. *By Professor J. A. S. Watson.* 1930. *Agricultural Progress. The Journal of the Agricultural Education Association, Vol. 7, pp.* 96-101.—Professor Watson bases his arguments on the assumption that there is no immediate likelihood of it being found practicable to ship Australian meat in a chilled state instead of frozen, and that there is no immediate likelihood that the United States will open her doors to South American chilled beef. He points out that there have been consistently low prices for cattle during the past eight years as contrasted with the consistently high prices for sheep. In dealing with home production he states that our national herd of cattle has increased fairly steadily since 1770, but that this increase appears to have been confined to the dairy section. Dr. Keith Murray finds that there is a considerable correlation between the number of "other cattle under two years old" and the price of fat cattle in the succeeding year. On this basis the decline in cattle numbers should have been sufficient, other things being equal, to raise the index figure by 5 points during the year 1929 and should have led to a further rise in 1930. Professor Watson points out that the proportion of home-produced cow beef is steadily increasing and that of steer and heifer beef is diminishing. Further, there has been a considerable change in the seasonal distribution of our home supplies. Since 1914 our root (turnips, &c.) acreage has fallen by 28 per cent., and this has led to more cattle reaching the fat markets in the periods September to December and fewer in the period March to June. This is being met by cold storing a proportion of the autumn supply, but has not prevented a widening difference in seasonal prices. For the period 1911 to 1914 the difference between June and November prices was 10 per cent., whereas for the past four years it has been about 21 per cent.

In dealing with imported supplies (a subject which has already been covered by

Sir Wm. Haldane and reviewed in these pages) Dr. Murray has again found that the correlation between the supply of imported beef and the price of home fat cattle is of a comparatively low order. A decline of 10 per cent. in imports will cause a rise of 4 points in English fat cattle, and a rise of 7 points in that of inferior classes of home cattle. Thus a decline of say 20 per cent. will not raise prices to anything like a famine level, but should produce a flat rate increase of about 5*s.* per cwt. on all classes of home fed cattle.

With regard to home demand, in the past the increase of the human population of this country has had an important influence on the total demand. In 1900 our home production of 12 million cwt. sufficed to supply 37 lb. of beef per head per annum. In 1927 an almost identical output gave only 32 lb. per head. It is expected that the population of Great Britain will increase. Further, it is important to remember that meat is a luxury and that consumption varies according to the length of the consumer's purse. At the end of the eighteenth century the average working class family spent 9 per cent. of its income on meat when a pound of meat cost only three times as much as a pound of wheat; in 1900 the average working class family spent 17 per cent. of its income on meat, despite the fact that meat was nine times as dear as wheat. When the working man is prospering he will pay a good price for meat, but when he is poor he will buy it only at a low price. A 10 per cent. rise in the purchasing power of wages produces an 8 per cent. rise in the price of beef. Conditions in this country cannot be much worse than they have been, and when they return to normal meat may be expected to rise by about 10 points.

After dealing with the demand from other importing countries, Professor Watson comes to the conclusion that the outlook for the beef producer is good, but there is no reason to expect famine prices. He ventures to predict that beef prices will recover within the next two years to a level at least as high as that of the agricultural index figure, and that for the succeeding period of perhaps six or seven years we shall see beef relatively dear, and he further concludes that the seasonal variation in prices will become still more marked than it has been in recent years.

Increasing Rate of Reproduction in U.S. Cattle Herds. *Armour's Monthly Letter, Vol.* 11, *No.* 5.—In the United States as in other countries there has been a gradual increase in the efficiency of cattle production over the past 30 years. The number of births per thousand cattle has steadily risen. The greater part of this increased efficiency is, however, due to dairy cattle; the lesser part is amongst the beef breeds. Interesting figures are given from several herds in America, and these show that steers are in general being marketed as yearlings and two-year-olds, whereas they were formerly being marketed as four-year-olds. With the adoption of the practice of slaughtering yearlings and two-year-olds, the same number of breeding cattle will in the future form a much larger proportion of all cattle than formerly. The number of calves raised per thousand cows is increasing. An additional point of some interest generally is that the average number of cows per bull varies from 18·7 to 25·7 and the percentage calf crop from 34 to 64.

Factors which Influence the Quality and Palatability of Meat. *By A. E. Trowbridge, A. G. Hogan, M. T. Foster, W. S. Ritchie, C. S. Maddox, Jessie Alice Cline, H. C. Moffett, Abs. in Miss. Agr. Exp. Sta. Bull.* 256, *pp.* 55-62.—In considering results achieved with range-bred high grade Hereford calves, brought up, fed and marketed under similar conditions, it was found that the net profit on the steers amounted to 3·28 dollars as compared to 6·21 dollars on the heifers. The steers consumed somewhat smaller quantities of concentrate and hay, but the heifers ate rather less silage. Whereas the steers gave 57·1 per cent. dead to live weight and were graded "Good," the heifers gave a percentage of 58·2 per cent. and were graded as "High Good."

The work of the Sni-a-Bar Farm has been already referred to in these columns, and here is a further report on the improvement of this herd by the use of pure-bred bulls. Calves sired by grade bulls were valued at two dollars per cwt. less than those sired by good pure-bred bulls.

Size in Dairy Cattle. *By J. C. M'Dowell, U.S. Dept. Agr. Circ.* 114 (1930), *pp.* 4.—A study of the yearly individual records of nearly a quarter of a million cows revealed that in general within the same breed the heavier the cow the greater the total yield of milk, and also the greater yield of milk per pound of food consumed. While the larger animals ate more than the smaller ones, the increased consumption was not in proportion to the increase in production of milk. The conclusion is reached that, other things being equal, a large cow will produce more milk and return a greater profit than a small cow.

Length of Gestations in Jersey Cows. *By Lynn Copeland.* 1930. *Jour. Dairy Science, Vol.* 13, *No.* 3, *pp.* 257-265.—This adds to the many investigations which have been made concerning the length of gestation in cattle and includes an interesting review of the subject.

The author worked on the Register of Merit Records of the American Jersey Cattle Club, and the average gestation period for 1,075 cases studied was 278·51 days. This compares very closely with the figure obtained from much the same material by LaMaster and Elting.

The author states that there appears to be an equal chance of a cow calving any time between the 271st and the 285th day. The age of the dam had apparently no effect on the length of gestation. Bull calves were carried an average of one day longer than heifer calves, 297 bull calves showing an average of 279·48 days. while the gestation of 282 heifer calves averaged 278·64 days. The gestation of twins appeared to be usually several days shorter than the average, while calves resulting from abnormally long gestations seemed to have a better chance of living than those born prematurely. No correlation could be detected between the length of the different gestations in the same individual dam.

Investigations on the Bang Abortion Disease in Cattle and Swine. *By J. W. Connaway. Abs. in Miss. Agr. Exp. Sta. Bull.* 256, *pp.* 97–100.—The object in this experiment was to find out whether the progeny of animals infected with the Bang-abortion bacteria were themselves likely to be infected. Although each calf of an infected dam remained with its mother continuously during the full lactation period and imbibed the infected milk at will until weaned naturally, it did not appear to have received any *permanent* infection. The positive antibody reaction of the blood of the calf in every case disappeared before the advent of sexual maturity; in no instance did one of the calves of the infected cows acquire permanent infection after reaching sexual maturity, although exposed at pasture to the infected and positive infected dams and grandams. Thus we find convincing proof that the progeny of the relatively immune abortion-infected cows can by proper management be reared to maturity under practical farm conditions without acquiring a permanent infection with the Bang-abortion bacterium from the infected dams.

Horses.

The Horse and Mule Outlook. *By B. H. Frame.* 1927. *Miss. Agr. Exp. Sta. Circ.* 157, *p.* 12. *Abs. in Miss. Agric. Exp. Stat. Bull.* 256, *p.* 17, 1927.—In the United States in 1919 there were nearly 26½ million horses and mules on farms, whereas in 1927 there were only 21 million. Eventually numbers must reach a new level of normality. When such a point is reached the formal cycle of production will again be restored, leading to the similar cycle in the money values based on the laws of demand and supply. The writer does not believe that there is any sign of the horseless farm. There appears also to be a sign of an upward trend in the value of horses in the United States.

Pigs.

Current Trend of World Hog Production. 1930. *Armour's Monthly Letter, Vol.* 11, *No.* 6.—While America no longer exercises a dominating influence in the world's cattle production she still has a considerable surplus of pig products which must be disposed of abroad. Thus the changes in pig population of other countries are a determining factor in the volume of the export trade in pork and lard, and this in turn has an important reflection on the cattle and sheep industry of that country. At the present time the international trade in pork and lard is largely determined by the balance between conditions in the United States and in Europe. The United States leads the world in surplus production of these products above domestic needs. In 1928 she produced for export 1,100 million lb., compared with Denmark, her nearest competitor, with 650 million lb., the Netherlands with 274 million and the Irish Free State with 115. Of the importing countries Great Britain heads the list with 1,400 million lb., Germany following with 240 million and France with 100 million.

The *per capita* pig population of Denmark is more than twice as great as that of any other nation of importance in commercial pig production and constitutes the outstanding feature in the European pig situation during the period 1926 to 1928. Bacon imports to the United Kingdom from the United States fell off rapidly owing to an increase of the Danish imports. During the summer of 1930 Danish bacon imports into the United Kingdom have passed the peak reached in 1923 and current levels constitute a new high record. Danish production is 80 per cent. above pre-war level, whereas the German production is at about pre-war level.

Peaks of pig production in recent years have tended to come at the same time in the United States, Germany, Canada, the United Kingdom and Denmark. Pig breeding in the Argentine is increasing slowly, but slaughter for export has increased rapidly in recent years.

Fecundity of Swine: The Normal Sexual Cycle, as influenced by Unfavourable Dietary Conditions. *By A. G. Hogan, F. F. M'Kenzie. Abs. in Miss. Agr. Exp. Stat. Bull.* 256, *pp.* 46 *and* 47, 1927.—There are very marked changes in the genital tract of the sow from one heat period to the next. It was found that by keeping gilts on the medium and low planes of nutrition the result was to delay the first pig crop by over two months. Early breeding has not meant much retardation of the growth of sows so long as they were well fed and well cared for. Continued early breeding for 18 years has not detrimentally affected the ability of the later generation sows to wean heavy pigs. The first month after a sow has been successfully mated appears to be an important time to maintain the gaining condition of the animal. When sows gained below the average for the group during the first month after being bred they produced litters below the average in size at birth and at weaning time.

Poultry.

The Relation of the Date of Sexual Maturity to Egg Production. *By H. L. Kempster.* 1926. *Miss. Agr. Exp. Sta. Res. Bul.* 88, *pp.* 3–12. *Abs. in Miss. Agr. Exp. Stat. Bull.* 256, *pp.* 18, 1927.—The studies forming the basis of this report have extended over seven years and include the trap-nest records of 1,110 White Leghorns. Correlation studies were made between date of sexual maturity and winter egg production, and date that laying ceased. The author concludes that the optimum date of sexual maturity is about November 1. Early layers make the best winter and annual records. There is a slight tendency for early layers to postpone the date on which they cease laying.

ANIMAL NUTRITION.

Potassium Iodide as a Mineral Supplement in Paired Feeding Experiments with Growing Swine. *W. E. Carroll, H. H. Mitchell, and G. E. Hunt. J. Agric. Res.* 1930, 41, 65.—A considerable amount of experimental work has been carried out in different countries on the effect on growth and health of adding iodine to the rations of animals, and the results on the whole are conflicting. In certain areas where there appears to be a deficiency of iodine in the soil and foodstuffs beneficial results have been obtained, as, for example, in parts of the United States where the addition of iodine to the sow's ration was found to prevent hairless disease in young pigs. In other areas again, results were negative. The experiments detailed in this paper were carried out in an area where goitre in farm animals is very rare. The paired-feeding method was employed in the case of 13 pairs of Poland-China pigs weighing initially from 57 to 76 lb. and finally about 175 lb. No evidence was obtained that the administered potassium iodide, equivalent to one grain of iodine daily, in any way affected the rate of growth. In 7 of the 13 pairs the control pig made the more rapid gain. The basal ration used contained ground yellow corn, tankage, linseed meal, alfalfa meal and sodium chloride.

Influence of Small Quantities of Potassium Iodide on the Assimilation of Nitrogen, Phosphorus and Calcium in the Growing Pig. *F. J. M'Clure and H. H. Mitchell. J. Agric. Res.*, 1930, 41, 79.—In metabolism experiments upon five pigs, in which potassium iodide was administered for 14 days in doses of 0·248 gm., and in which 14-day control periods preceded and followed this régime, there was no evidence that the utilisation of either nitrogen, calcium or phosphorus was favourably affected. There was some indication that the retention of calcium was adversely affected. No effect of the iodide administration on the rate of growth of the pigs was evident.

This would appear to conflict with the results obtained in a similar experiment by Kelly (*Biochem. J.*, 1925, 19, 559), who found that administration of potassium iodide increased the retention of nitrogen and phosphorus and less definitely of calcium. Although the present experiment was carried out to confirm Kelly's results, differences in technique are noted as, for example, in the use by M'Clure and Mitchell of cod liver oil, which is rich in iodine, in the basal ration.

The Relation of the Protein Requirement of Chicks to the Rate of Growth: I. The Quantity of Protein required by Chicks during early Growth. *L. C. Norris and G. F. Heuser. Poultry Sci.*, 1930, 9, 378.—In these experiments the greatest growth in chicks during the first eight weeks after hatching was obtained on rations which contained approximately 20 per cent. protein. The effect of a larger amount was not determined. The parallel growth curves of chicks which received 15 to 16 per cent. protein after eight weeks indicate that the protein requirement thereafter is in the neighbourhood of this amount. The efficiency of protein utilisation in chicks of the same age decreased with each increment of protein. Differences in growth obtained on the same protein levels was probably caused by differences in the quality of the protein of the various supplements. Both the efficiency of protein utilisation and of feed utilisation of the chicks decreased with advancing age.

The Value of Potassium Iodide as a Supplement to the Ration of Growing Chicks. *T. S. Hamilton and C. H. Kick. J. Agric. Res.*, 1930, 41, 135.—In a feeding experiment involving 18 White Leghorn chicks, individually fed so that birds whose gains were to be compared were of approximately the same initial weight and received approximately the same amount of food, no evidence was obtained that a supplement of potassium iodide at the rate of 0·5 mgm. or of 1·0 mgm. daily per 100 gms. of body weight in any way influenced the rate of growth. The basal ration consisted of yellow corn 65 parts, wheat bran 10 parts, middlings 10 parts, tankage 10 parts, steamed bone meal 3 parts, sodium chloride 1 part and charcoal 1 part.

The Biochemistry of Aluminium: I. Excretion and Absorption of Aluminium in the Pig. *K. Mackenzie. Biochem. J.*, 1930, 24, 1433.—In these experiments the utilisation of aluminium by young pigs has been examined and the path of excretion determined. An attempt has also been made to ascertain if the excretion of urinary phosphorus is disturbed by the use of aluminised diets and the amount of aluminium present in various organs has been determined. It has been found from the results of balance experiments that the intake and excretion of aluminium in the pig are equal. Aluminium excretion is confined solely to the alimentary tract. The absorption of aluminium from normal diets containing moderate amounts of available aluminium, as determined by the analysis of the organs, is small. Diversion of phosphates from the urine to the fæces does not occur on such diets. No harmful effect on general growth and metabolism results from feeding comparatively large amounts of aluminium.

Nutritive Value of Pasture: VI. The Utilisation by Sheep of Mineral-Deficient Herbage. *H. E. Woodman and R. E. Evans. J. Agric. Sci.*, 1930, 20, 587.—Pastures deficient in mineral matter are usually found to be deficient in energy-yielding constituents. The question has arisen, therefore, whether the failure of animals to thrive on mineral-deficient pastures might be attributed to the energy-deficient character of the herbage. Further, the digestibility of the organic constituents of the herbage may be depressed in the absence of a sufficient supply of mineral matter, while this latter factor might confer an unpalatable character on the herbage. Again the physiological utilisation of the digested nutrients may not proceed normally if the amount of minerals in the diet is deficient. These are the problems investigated by the authors in digestibility trials with sheep using a poor quality of hay of very low mineral content. From the experiments the following conclusions are drawn.

The results lead to the belief that the failure of stock to thrive in mineral-deficient pastoral areas cannot be explained by assuming that the low mineral content is responsible for a lack of palatability in the herbage and a consequent depression of appetite in the grazing animals. Neither is there any evidence that the shortage of minerals causes the herbage to be digested any less-efficiently than "normal" cultivated herbage of similar maturity and organic constituents.

Malnutrition on pasturage of sub-normal mineral content is due directly to the failure of the diet to supply the necessary inorganic materials for constructional purposes and for maintaining the normal balance of minerals in the blood and tissues, and is not, even in part, to be ascribed to any indirect effect, such as is embodied in the suggestion that the mineral deficiency leads to under-nutrition of the animal by causing a depression of its appetite and its capacity to digest the organic constituents of the herbage.

The Importance of Solar Radiation in the Development of Growing Pigs. *A. M. Shaw. Scientific Agriculture*, 1930, 11, 1.—Experiments were carried out, in which light was the only variable, to determine the effect of sunlight on young growing pigs. All the pigs were fed alike with a good ration, sufficient as regards protein and mineral matter. The following are some of the main conclusions drawn.

Direct sunlight is necessary for normal development of pigs. Young pigs, fed what would ordinarily be called well-balanced rations but deprived of light, will develop rickets. Similar young pigs fed in the same manner but having access to open yards or direct light will remain normal. Light secured through ordinary window glass is of little value in preventing rickets. A special type of glass, now on the market at a high price, was found to have no advantage over ordinary glass. An ample supply of fresh green legumes prevented the onset of rickets. Young pigs show the effect of restricted light much more quickly than older pigs. Pigs of three or four months of age that have up to that period developed normally seem to be able to withstand long periods of restricted light. Access to direct light will cause rapid improvement in affected animals. Pigs which received direct light make significantly greater gains than all other groups.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in September, October and November 1930.

LIVE STOCK: Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	SEPTEMBER.			OCTOBER.			NOVEMBER.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK:—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	61 5	53 9	42 9	61 0	53 10	43 2	61 7	53 6	43 0
Cross-bred (Shorthorn)	57 2	49 7	36 2	56 0	49 1	37 0	57 1	49 6	38 4
Galloway	55 5	51 5	...	52 2	48 6	...	53 3	48 3	...
Ayrshire	53 0	43 3	33 9	52 0	42 7	32 3	52 0	42 9	31 3
Blue Grey	64 4	57 4	...	64 6	57 0	...	63 0	54 6	43 0
Highland	50 0	...	...	52 9	...	...	56 1	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	16	9	...	16	9	...	16	9	...
	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†SHEEP—	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Cheviot	13¾	11	8½	13½	10¾	8¼	12¾	10¾	8¼
Half-bred	13½	11½	8	13¼	11¼	7¼	12¾	11	7½
Blackface	13¾	11¾	9	13¼	11¼	8¼	13	11½	8¼
Greyface	13¾	12¼	9	13½	11½	8	13	11¾	8¼
Down Cross	13¾	11¼	8¼	12¾	10¾	7½	13	10¾	7¼
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	12 7	11 8	...	12 0	11 3	...	12 0	11 1	...
Porkers	13 6	12 5	...	13 6	12 5	...	13 3	12 4	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	SEPTEMBER.			OCTOBER.			NOVEMBER.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—									
Aberdeen-Angus :	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*	Per head. £ *s.*
Yearlings	17 3	14 0	12 18	17 18	13 18	12 6	15 19	14 4	11 15
Two-year-olds ...	24 3	18 13	16 0	23 3	18 1	15 17	22 12	18 1	16 5
Cross-bred (Shorthorn):									
Yearlings	16 9	13 4	10 15	16 14	13 3	11 5	15 8	12 16	11 4
Two-year-olds ...	22 11	17 9	15 0	22 6	17 10	14 10	21 16	17 4	15 15
Galloway :									
Yearlings	15 3	11 0	...	16 15	12 0	...	14 1	...	...
Two-year-olds ...	23 5	18 5	...	21 19	18 0	...	...	16 18	...
Ayrshire :									
Yearlings	11 18	...	...	12 13	10 10	...	12 5	...	...
Two-year-olds ...	14 10	...	...	18 10	13 15	...	16 0	...	...
Blue Grey :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	20 15	...	...	23 3	...	...	...	...	...
Highland :									
Yearlings	10 0	...	...	12 1	10 1	7 5	11 14	9 8	6 10
Two-year-olds ...	...	14 2	12 0	17 8	13 7	11 1	16 0	14 5	11 15
Three-year-olds ...	23 0	19 0	15 0	21 13	16 14	14 2	21 7	15 15	...
DAIRY COWS—									
Ayrshire :									
In Milk	31 13	20 15	12 0	29 7	20 2	12 10	30 19	21 3	12 0
Calvers	28 1	19 1	14 0	28 3	19 16	14 12	29 6	21 1	15 8
Shorthorn Cross :									
In Milk	32 18	24 8	20 0	33 0	24 5	...	33 0	25 6	...
Calvers	30 4	21 3	17 0	30 17	21 16	17 15	31 16	22 12	18 5
SHEEP—	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Cheviot Hoggs ...	...	...	...	37 6	25 0	...	25 9	...	...
Half-bred Hoggs ...	53 2	27 0	...	46 5	30 0	...	45 9	36 0	...
Blackface Hoggs ...	...	...	...	44 2	34 6	...	32 8	24 6	...
Greyface Hoggs ...	...	...	...	60 0	56 0	...	43 6	33 0	...
Down Cross Hoggs	...	...	...	36 0	28 0	...	48 0	38 0	...
PIGS—									
(6 to 10 weeks old)	45 1	31 11	...	40 5	27 8	...	35 11	25 0	...

DEAD MEAT : Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	SEPTEMBER.			OCTOBER.			NOVEMBER.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF :—		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Home-fed—										
Bullock or Heifer ...	1	9	9¼	10	8¾	8½	9¾	8¾	8⅜	9½
	2	8½	...	9¼	8¼	...	8⅝	8¼	...	8
Bull	1	7½	7⅛	7	7½	6⅞	7	7½	6⅞	6⅞
	2	7¼	7	6½	7	6½	6¼	7	6	6
Cow	1	6½	6⅛	6¾	6½	5⅞	6⅜	6¼	5⅞	6⅛
	2	6	...	6	6	...	5¾	5⅞	...	5½
Irish—										
Bullock or Heifer ...	1	...	...	8⅜	...	...	7⅞	...	...	8
	2	...	...	7⅝	...	...	7¼	...	...	7⅜
Argentine Frozen—										
Hind Quarters ...	1	6	7⅛	...	6⅛	7⅜	...	5¾	6⅞	...
	2	5¾	5⅞	...	6	5⅝	...	...	5⅛	...
Fore ,, ...	1	4⅜	4⅝	...	4⅞	5	...	4¾	5⅛	...
	2	...	4⅛	..	4⅝	4½	...	...	4⅝	...
Argentine Chilled—										
Hind Quarters ...	1	7⅜	7⅜	7⅞	7⅝	7½	8⅛	7⅜	7	7⅞
	2	...	6⅝	7⅜	7¼	6½	7¼	7	6¼	7⅛
Fore ,, ...	1	4½	4½	4¾	5¼	5	5⅛	5¼	5	5
	2	...	4⅛	4⅜	5	4⅜	4¾	5	4½	4⅝
Australian Frozen—										
Hind Quarters ...	1	...	...	5⅞	...	...	6	...	...	5¾
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	4⅜	...	...	4⅝	...	...	4⅝
New Zealand Frozen—										
Hind Quarters ...	1	..	...	5⅞	...	...	6	...	...	5½
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	...	4⅛	...	...	4½	...	...	4½
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	13	11⅞	12⅛	12⅜	10¾	11⅝	12	10½	11
	60 lb. & over	12½	...	11	11¾	...	10⅝	11	...	10
,, Cross	under 60 lb.	13	11⅞	12⅛	12⅜	10¾	11⅝	12	10½	11
	60 lb. & over	12½	...	11	11¾	...	10⅝	11	...	10
Ewes, Cheviot	1	...	7¾	7¾	...	7¼	7½	...	6½	7⅜
	2	...	...	7¼	...	...	6⅞	...	...	6¾
,, Blackface ...	1	10	7¾	7¾	9¼	7¼	7½	8½	6½	7⅜
	2	9	...	7¼	8¼	...	7	7½	...	6¾
,, Cross	1	8	7¾	7¾	7¼	7¼	7½	7	6½	7⅝
	2	7	...	7¼	7	...	6⅞	6	...	6¾
Argentine Frozen ...	1	...	...	4⅞	...	...	5¼	...	...	5⅜
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	5½	5	...	5¾	5¼	...	5⅝	4⅝
	2	...	3¾	4	...	4¼	4¾	...	4⅜	4⅛
New Zealand ,, ...	1	...	...	4⅛	...	...	5½	...	...	4⅞
	2	...	...	3⅝	...	...	4⅝	...	...	4⅜
LAMB :—										
Home-fed	1	14⅜	13⅜	13⅜	13	12¼	12¾	12⅜	11	12
	2	14	...	12	...	...	11⅝	...	...	11
New Zealand Frozen ...	1	...	9½	9⅜	...	9¼	9¼	...	9	9¼
	2	...	8⅞	8¾	...	8¾	...	...	8⅜	...
Australian ,, ...	1	...	...	7¾	...	...	7¾	...	...	7¾
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	7¾	...	...	7¾	...	...	7¾
	2	...	...	...	...	...	...	...	...	...

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

Provisions: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.		Quality.	September. s.	September. d.	October. s.	October. d.	November. s.	November. d.
Aberdeen.	Country ...	... per doz.	1	1	8	2	1	2	7
			2	1	7	2	0	2	6
	Duck ...	... ,,	1	1	9	2	1	2	7
			2	1	8	2	0	...	
Glasgow.	Country ..	... per doz.	1	1	11	2	4	2	11
	Irish ...	... per 120.	1	17	3	24	6	26	2
			2	15	1	18	10	23	9
	,, Duck ...	... ,,	1	12	11	15	3	17	3
	,, (Cold stored) ...	,,	1	12	5	13	8	14	4
			2	...		13	5	13	7
	American ...	... ,,	1	...		15	9	13	6
	Australian ...	... ,,	1	...		17	4	17	10
			2	...		16	6	17	1
	Belgian ...	... ,,	1	14	8	17	1	20	3
			2	...		14	11	...	
	,, (Pickled) ...	,,	1	...		12	11	11	9
	Chinese (Black) ...	,,	1	8	2	...		...	
	,, (Duck) ...	,,	1	...		10	6	...	
	Danish ...	... ,,	1	14	4	16	4	13	9
	,, (Pickled) ...	,,	1	...		...		12	6
	Dutch ...	... ,,	1	...		15	4	...	
	,, (Duck) ...	,,	1	11	2	...		...	
	,, (Pickled) ...	,,	1	...		...		11	3
	Polish ...	... ,,	1	9	6	12	6	12	9
			2	7	8	10	7	11	1
	Swedish ...	... ,,	1	14	1	15	10	...	

Description.		Quality.	September. s.	September. d.	October. s.	October. d.	November. s.	November. d.
BUTTER:								
Irish Creamery ...	... per cwt.	1	136	3	127	2	120	4
,, ,, (Unsalted)	,,	1	140	3	131	2	124	4
Australian ...	... ,,	1	133	6	127	2	116	0
Danish	... ,,	1	152	0	152	5	144	0
,, (Unsalted) ...	,,	1	156	0	156	5	148	0
New Zealand ...	... ,,	1	136	0	128	5	119	3
,, (Unsalted) ...	,,	1	158	0	159	0	125	0
Siberian	... ,,	1	131	0	118	8	116	6
Swedish	... ,,	1	144	9	138	0	137	9
CHEESE:								
Cheddar ...	... ,,	1	88	11	86	8	90	5
		2	79	2	76	7	78	9
Cheddar Loaf ...	... ,,	1	94	6	94	5	95	6
Dunlop	... ,,	1	78	9	78	2	83	3
		2	73	9	70	6	72	8
Canadian... ...	... ,,	1	84	9	84	0	84	3
New Zealand (Coloured)	,,	1	83	9	81	10	82	3
,, (White)	,,	1	81	6	82	0	83	9
HAMS:								
Irish (Smoked) ...	... ,,	1	192	0	192	0	172	0
		2	189	0	186	0	158	6
American, Long Cut (Green)	,,	1	113	3	112	7	108	9
,, Short Cut ...	,,	1	98	6	96	10	102	0
BACON:								
Ayrshire (Rolled) ...	,,	1	132	6	125	2	124	0
Irish (Green)	,,	1	111	6	106	10	110	6
,, (Dried or Smoked)	,,	1	120	0	114	10	116	6
,, (Long Clear) ...	,,	1	121	0	107	10	107	9
Wiltshire (Green) ...	,,	1	125	0	120	10	120	0
,, (Dried or Smoked)	,,	1	132	0	128	2	128	0
Danish, Sides	,,	1	93	9	78	5	81	6
Dutch, Green (Wiltshire Style)	,,	1	85	0	72	2	75	0
American (Long Clear Middles), Green	,,	1	96	0	...		...	
American (Short Clear Backs)	,,	1	98	0	96	0	93	6

FRUIT AND VEGETABLES : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.	Quality.	SEPTEMBER.		OCTOBER.		NOVEMBER.	
FRUIT :—							
Apples —		s.	d.	s.	d.	s.	d.
British—							
Bramley Seedling ... per barrel.*	1	10	0	8	3	...	
Other Cooking ... ,, *	1	10	2	8	2	...	
Lord Derby ... ,, *	1	10	0	9	0	....	
Imported —							
American ... ... per case.†	1	13	6	11	9	...	
,, ... per barrel ‡	2	23	0	25	7	26	6
Canadian ... ... per case.†	1	...		11	5	9	11
,, ... per barrel.‡	2	..		25	2	26	0
Pears—							
British ... ... per case.§	1	6	9	...		...	
Californian ... ... ,, ‖	1	20	0	17	0	14	9
Blackberries .. ... per lb.	1	0	5	0	5¼	...	
Damsons ... ... ,,	1	0	1¾	0	1¾	...	
Plums—							
Egg ... ... per lb.	1	0	1¼	..		....	
Monarch ... ... ,,	1	0	2	...		...	
Prolific ... ... ,,	1	0	1¾	...		...	
Victoria ... ... ,,	1	0	3¼	...		...	
VEGETABLES :—							
Beans—							
Dwarf ... ... per lb.	1	0	3	0	7	1	0
Scarlet Runner ... per stone.	1	3	0	3	1	3	6
Beet ... ... per cwt.	1	5	9	4	2	3	11
Brussels Sprouts ... ,,	1	4	5 *a*	23	0	18	0
Cabbage, Coleworts ... per doz.	1	1	3	1	3	1	3
,, Red ... ... ,,	1	3	2	2	7	3	2
,, Savoy ... ... ,,	1	2	0	1	11	1	9
Carrots ... ... per cwt.	1	5	9	5	0	4	9
Cauliflower—							
Broccoli, Cornish ... per doz.	1	...		4	0	4	6
Other British ... ,,	1	2	8	3	0	3	8
French ... ... ,,	1	...		4	4	4	9
Celery ... ... per bunch.	1	2	0	1	10	1	9
Cucumber ... ... per doz.	1	5	6	5	10	10	6
Greens ... ... per doz. bunches.	1	8	0	7	5	6	9
Leeks ... ... ,, ,,	1	2	9	2	0	2	2
Lettuce, Cos ... ... per doz.	1	1	2	1	0	1	0
,, Cabbage ... ,,	1	1	2	1	0	1	0
Onions, *Dutch* ... per bag.¶	1	4	0	4	6	4	8
,, *Valencia* ... per case.**	1	7	6	7	6	7	9
,, *Spring* ... ... per bunch.	1	0	4	0	4	0	4½
Parsley ... ... per cwt.	1	12	0	12	0	12	0
Parsnips ... ... ,,	1	9	6	7	5	7	0
Peas ... ... ,,	1	21	0	24	0	...	
Radishes ... ... per doz. bunches.	1	1	6	1	6	1	6
Rhubarb ... ... per cwt.	1	4	3	5	0	...	
Spinach ... ... ,,	1	24	0	24	10	32	0
Tomatoes, *Scottish* ... per lb.	1	0	7	0	6¾	0	9
,, *Channel Islands* ,,	1	0	3	0	3½	0	3¾
,, *Canary* ... ,,	1	...		...		0	5¾
,, *Dutch* ... ,,	1	0	2½	0	3	0	2½
Turnips ... ... per cwt.	1	2	11	2	4	2	2
Vegetable Marrow ... per doz.	1	3	3	2	11	4	6

56 lb. (approx.). † 40 lb. (approx.). ‡ 10 stone (approx.). § 36 lb. (approx.).
‖ 46 lb. (approx.). *a* Per 20 lb. ¶ 1 cwt. (approx.) ** 9 stone (approx.).

POTATOES : Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	FIRST EARLIES.	SECOND EARLIES.	LATE VARIETIES.			
				RED SOILS.		OTHER SOILS.	
				Golden Wonder.	Other.	Golden Wonder.	Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
		SEPTEMBER.					
Aberdeen, per ton	1	...	4 1 3	...	...	...	...
Dundee ,,	1	...	3 16 3	...	...	...	3 15 0
Edinburgh ,,	1	...	4 1 11	...	...	8 0 0	4 5 0
Glasgow ,,	1	4 10 0	3 18 9	...	...	...	4 5 0
		OCTOBER.					
Aberdeen ,,	1	...	...	...	...	...	4 4 6
Dundee ,,	1	...	3 15 0	...	...	...	3 15 0
Edinburgh ,,	1	...	4 11 0	...	...	...	...
Glasgow ,,	1	3 10 0	3 14 0	...	...	6 15 0	4 0 0
		NOVEMBER.					
Aberdeen ,,	1	...	...	...	...	...	4 0 8
Dundee ,,	1	...	...	...	...	...	3 15 0
Edinburgh ,,	1	...	4 6 3	...	..	...	4 7 6
Glasgow ,,	1	...	3 11 3	...	...	6 18 9	3 18 2

ROOTS, HAY, STRAW AND MOSS LITTER : Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	ROOTS.			HAY.		STRAW.			MOSS LITTER.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Oat.	Barley.	
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
		SEPTEMBER.								
* Aberdeen, per ton	1	...	...	...	60 0	...	...	26 3	...	...
‖ Dundee ... ,,	1	...	18 0	...	105 0† 93 4‡	...	57 6	57 6	...	52 6§
¶ Edinburgh ,,	1	...	...	...	85 0† 81 3‡	...	48 2	46 3	...	...
‖ Glasgow ,,	1	...	...	...	80 0	85 0	45 0	42 6	...	33 9§§
		OCTOBER.								
* Aberdeen ,,	1	...	...	..	68 0	...	...	27 6	...	...
‖ Dundee ... ,,	1	...	18 0	...	93 0† 80 0‡	...	57 0	57 0	...	52 6§
¶ Edinburgh ,,	1	...	...	...	89 2† 80 3‡	...	52 6	48 0	...	...
‖ Glasgow ,,	1	...	...	...	80 0	85 0	45 0	42 6	45 0a	33 9§§
		NOVEMBER.								
* Aberdeen ,,	1	...	...	...	70 0	...	...	28 2	...	...
‖ Dundee ... ,,	1	...	14 6	17 0	85 0† 75 0‡	...	50 0	50 0	...	52 6§
¶ Edinburgh ,,	1	...	...	...	90 0† 80 8‡	...	50 0	53 9	45 0	...
‖ Glasgow ,,	1	...	...	...	77 6	82 6	45 0	42 6	...	33 9§§

* Loose, ex farm.
† Baled and delivered.
§§ Home (in 1½ cwt. bales).
‖ Baled straw, delivered.
‡ Loose, delivered.
a Baled, on rail.
¶ Bunched straw, delivered.
§ Foreign, ex quay.

FEEDING STUFFS : Monthly Average Prices at Glasgow and Leith.

(*Compiled from Returns received from the Department's Market Reporters.*)

Description.	SEPTEMBER.		OCTOBER.		NOVEMBER.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	10 3 5	9 15 0	9 13 0	9 4 0	9 6 3	8 18 9
Foreign	9 8 2	...	8 19 9	...	8 13 9	...
Decorticated Cotton Cake	9 0 11	...	8 15 9	...	8 8 2	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	4 15 0	...	4 1 0	...	4 5 0
Egyptian (do.)	5 8 9	5 5 0	4 13 6	4 6 0	4 13 9	4 10 0
Palmnut Kernel Cake	7 19 5	...	8 0 0	...	8 0 0	...
Soya Bean Cake ...	...	8 15 0	...	8 15 0	...	8 16 11
Coconut Cake ...	8 15 0	..	8 12 0	...	8 5 0	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	6 1 3	6 0 0	5 9 6	5 15 0	5 3 9	5 15 0
(39-40 per cent. do.)	6 1 11	6 5 0	5 13 0	5 18 2	5 6 3	...
Maize Germ Cake—						
Home	8 1 11	...	8 3 6	...	8 5 8	...
Foreign	8 0 0	...	8 0 0	...	8 0 0	...
Maize Germ Cake Meal	6 14 5	..	6 7 6	...	6 0 11	...
Rice Meal	5 7 6	4 15 0	5 3 0	4 9 5	4 15 0	4 7 6
Bean Meal	10 10 0	10 5 0	9 18 0	10 0 0	9 10 0	9 17 6
Barley Meal ...	7 0 0	6 16 8	6 12 0	6 12 6	6 0 0	6 10 0
Fish Meal	19 0 8	18 2 6	19 5 0	18 0 0	19 2 6	18 0 0
Maize Meal—						
Home-Manufactured	8 7 6	7 18 2	7 15 6	6 16 6	6 9 5	6 5 0
South African—						
(Yellow) ...	6 18 9	6 15 0	6 11 3	6 5 8	5 19 1	5 16 8
(White) ...	6 13 2	6 10 0	6 6 6	...	5 19 5	4 12 6
Locust Bean Meal (Fine)	6 11 11	5 15 0	6 10 0	5 15 0	6 10 0	5 15 0
Maize Gluten Feed (Paisley) ...	6 5 0	...	6 3 0	...	5 15 0	...
Maize—Plate ...	7 8 5	7 15 0	6 0 6	5 17 0	5 4 5	4 19 5
Do. African, Flat	7 3 9	...	6 9 0	5 7 6	5 10 8	4 15 0
Do. American ...	7 6 3	...	6 19 0	...	7 2 6	...
Oats—Home ...	8 0 4	7 3 9	8 11 0	6 14 0	9 1 3	6 5 0
Do. Plate ...	5 13 2	...	5 0 3	...	4 12 2	5 0 0
Barley Feeding (Home)	7 15 0	7 0 0	7 10 0	6 0 0	7 2 6	6 0 0
Do. Bran ...	6 15 0	...	6 6 0	...	6 0 0	...
Wheat—						
Home	9 4 1	8 15 0	8 14 6	8 6 0	9 2 6	7 7 6
Poultry	8 10 0	8 13 4	8 12 6	8 5 0	7 7 6	7 10 0
Imported... ...	8 13 9	...	8 0 6	...	8 3 9	...
Middlings (Fine Thirds or Parings)	7 8 5	6 12 6	6 15 3	6 1 0	6 2 10	5 15 0
Sharps (Common Thirds) ...	5 8 9	5 5 0	4 19 9	4 14 0	4 15 4	4 13 9
Bran (Medium) ...	5 5 11	5 6 3	4 17 0	4 10 0	4 17 2	4 15 0
,, (Broad) ...	5 10 0	6 1 3	5 0 5	5 5 0	5 0 0	5 10 0
Malt Culms... ...	4 3 9	3 19 5	3 17 6	3 10 10	3 16 11	3 15 0
Distillery Mixed Grains—Dried	...	6 10 0	...	6 7 6	...	6 7 6
Brewers' Grains—						
Dried	5 9 5	4 12 6	5 10 0	4 7 0	5 4 1	4 8 9
Distillery Malt Grains —Dried	5 19 5	...	5 14 6	...	5 12 10	...
Crushed Linseed ...	23 10 0	...	22 6 0	...	20 0 0	...
Locust Beans, Kibbled and Stoned	5 10 8	5 0 0	5 7 0	4 17 6	5 5 0	4 17 6
Beans—China ...	9 11 11	9 5 0	9 4 0	9 0 0	8 16 11	8 17 6
Do. Sicilian ...	9 10 0	...	9 1 3	...	...	...
Do. English ...	9 13 9	...	9 12 0	...	8 7 2	...
Pease—China (White)	...	...	...	...	9 6 3	...
Feeding Treacle ...	6 0 0	6 7 0	6 0 0	6 9 5	6 0 0	6 10 0
Linseed Oil, per gall.	0 4 0	...	0 4 0	...	0 3 8	...

Fertilisers : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	September.						October.						November.					
		Glasgow.			Leith.			Glasgow.			Leith.			Glasgow.			Leith.		
		per ton.			per ton.			per ton.			per ton.			per ton.			per ton.		
	%	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Nitrate of Soda * ...	N. 15½	9	7	0	9	7	0	9	8	7	9	9	0	9	12	0	9	9	0
Sulphate of Ammonia (Neutral and Granular) * ...	N. 20·6	8	19	0	8	19	0	9	0	7	9	1	0	9	3	0	9	3	0
Nitrochalk * ...	N. 15½	9	7	0		..		9	7	0		...		9	7	0		...	
Calcium Cyanamide †	N. 20·6		...			...		8	7	0		...		8	9	0		...	
Superphosphate ...	P.A. 13·7	2	15	0	2	17	6	2	16	0	2	17	6	2	16	3	2	17	6
,, ...	,, 16	3	1	3	3	2	6	3	2	3	3	2	6	3	2	6	3	2	6
,, ...	,, 17·4	3	6	3		...		3	6	3		...			...			...	
,, ...	,, 18·3		...		3	7	6	3	7	6	3	7	6	3	7	6	3	7	6
Ground Mineral Phosphate ‡	P.A. 26		...		2	10	0		..		2	10	0		...		2	10	0
,, ,, ,, §	,, 26	2	10	0		...		2	10	0		...		2	10	0		...	
,, ,, ,, ‡	,, 34		...		3	10	0		...		3	10	0		...		3	10	0
,, ,, ,, §	,, 34	3	10	0		...		3	10	0		...		3	10	0		...	
Potassic Mineral Phosphate	P.A. 21 Pot. 5	3	5	0		...		3	5	0		...		3	5	0		...	
,, ,, ,,	P.A. 18 Pot. 9	3	10	0	3	7	6	3	10	0	3	7	6	3	10	0	3	7	6
Kainit (in bags) ...	Pot. 14	‖3	5	9	3	0	0	‖3	5	9	3	0	0	‖3	6	9	3	0	0
Potash Salts ...	Pot. 20	‖3	15	6	3	7	6	‖3	15	6	3	7	6	‖3	16	6	3	7	6
,, ,, ..	Pot. 30	‖5	2	0	4	10	0	‖5	2	0	4	10	0	‖5	1	3	4	10	0
Muriate of Potash ‖ (on basis of 80 per cent. purity)	Pot. 50	9	6	0		..		9	6	0		...		9	3	6		...	
Sulphate of Potash ‖ (on basis of 90 per cent. purity)	Pot. 48·6	11	6	9		...		11	6	9		..		11	3	6		...	
Steamed Bone Flour	N. 0·8/1·0 P.A. 27·5/30	5	15	0		...		5	15	0		...		5	15	0		...	
Bone Meal (Home)	N. 3·29 P.A. 23	7	15	0		..		7	15	0		...		7	15	0		...	
,, ,, (Indian)	N. 4 P.A. 19.25	8	15	0		...		8	15	0		...		8	0	0		...	
Potassic Slag ...	P.A. 12 Pot. 6		...		3	12	6		..		3	12	6		...		3	12	6
Basic Slag	P.A. 11	*a* 1	19	0		...		*a* 1	19	0		...		*a* 1	19	0		...	
,, ,, ...	,, 12	*a* 2	1	6		...		*a* 2	1	6		..		*a* 2	1	6		...	
,, ,, ...	,, 13	*a* 2	4	6	*b* 1	15	0	*a* 2	4	6	*b* 1	15	0	*a* 2	4	6	*b* 1	15	0
,, ,, ...	,, 14	*a* 2	7	0	*b* 1	17	0	*a* 2	7	0	*b* 1	17	0	*a* 2	7	0	*b* 1	17	0
,, ,, ...	,, 15		...		*b* 2	1	0		...		*b* 2	1	0		...		*b* 2	1	0
,, ,, ...	,, 15¾		...		*b* 2	5	0		...		*b* 2	5	0		...		*b* 2	5	0
,, ,, ...	,, 15		...		*c* 2	12	6		...		*c* 2	12	6		..		*c* 2	12	6
,, ,, ...	,, 15¾		...		*c* 2	15	0		...		*c* 2	15	0		...		*c* 2	15	0

Abbreviations :—N. = Nitrogen ; Pot. = Potash ; P.A. = Phosphoric Acid.

* Carriage paid in 6-ton lots. † Carriage paid in 4-ton lots.
‡ Fine grist 80 per cent. fineness through standard 100-mesh sieve.
§ ,, 90 ,, ,, ,, prescribed mesh sieve.
‖ Less 5s. 6d. per ton if lifted at quay.
a = F.O.R. Glasgow, in 6-ton lots, 80 per cent. citric soluble.
b = Ex-Grangemouth. *c* = At Leith, 80 per cent. citric soluble.

STATEMENT SHOWING THE ACREAGE UNDER EACH VARIETY OF POTATOES IN SCOTLAND IN 1930.

VARIETY.	Acres.	VARIETY.	Acres.
A. FIRST EARLIES.		*C.* MAINCROPS.	
1. *Dargill Early	79	25. *Sutton's Abundance (including Admiral, Balmuir, Bloomfield, Culdees Castle, Kerr's New White, Laing's Prolific, Lomond, Twentieth Century, Osborne Seedling, Just in Time, &c.)	665
2. *Di Vernon	80		
3. *Herald †	77		
4. *Immune Ashleaf ...	97		
5. *Snowdrop (including Witch Hill)	62		
6. Beauty of Hebron (including Puritan) ...	95		
7. Duke of York (including Midlothian Early and Victory)	1,794	26. *Arran Banner †	678
		27. *Arran Consul †	617
		28. *Arran Victory	284
8. Eclipse (including Sir John Llewelyn) ...	948	29. *Bishop	42
		30. *Champion	526
9. Epicure	7,703	31. *Crusader...	57
10. May Queen	127	32. *Early Market	45
11. Ninetyfold	209	33. *Golden Wonder (including Peacemaker) ...	7,986
12. Sharpe's Express ...	1,712		
13. Sharpe's Victor	23	34. *Irish Queen	410
14. Other First Earlies not specified above ...	114	35. *Kerr's Pink	39,097
		36. *Langworthy (including Maincrop and What's Wanted)	239
Total First Earlies ...	13,120		
		37. *Lochar	31
		38. *Majestic	5,657
		39. *Rhoderick Dhu	153
		40. *Tinwald Perfection ...	145
		41. Arran Chief	3,035
		42. Evergood	6
B. SECOND EARLIES.		43. Field Marshal	434
		44. General	26
15. *Ally	339	45. King Edward VII (including Red King) ...	15,146
16. *Arran Comrade	331		
17. *Catriona	163	46. Northern Star (including Ajax, Allies and Aeroplanes)...	27
18. *Edzell Blue	278		
19. *Great Scot	10,059		
20. *Katie Glover	21	47. President (including Iron Duke and Scottish Farmer)	96
21. *King George V	200		
22. British Queen (including Pioneer, Macpherson, Maid of Auchterarder, Scottish Standard, English Beauty, &c.) ...	3,518	48. Up-to-Date (including Dalhousie, Factor, Glamis Beauty, Scottish Triumph, Stephen, Table Talk, Laing's Imperial, &c.)	1,195
23. Royal Kidney (including Queen Mary)	252		
24. Other Second Earlies not specified above ...	201	49. Other Maincrops not specified above ...	356
Total Second Earlies	15,362	Total Maincrops ...	76,953
TOTAL AREA CLASSIFIED, ...			105,435
ACREAGE NOT INCLUDED, ...			17,923
TOTAL ACREAGE GROWN, ...			123,358

NOTES.—(1) The following districts are excluded:—In the county of Inverness—Skye, Harris, North and South Uist; in the county of Ross and Cromarty—Western, South-Western, Lewis.
(2) Returns showing a total area of less than one acre under potatoes are not tabulated.
(3) Varieties marked thus * are immune from Wart Disease.
(4) Varieties marked thus † have been registered by the Department of Agriculture for Scotland as new varieties.

ABSTRACT OF AGRICULTURAL RETURNS FOR SCOTLAND, 1930.

Collected 4th June 1930 (and comparison with 1929).

CROPS.

Distribution.	1930.	1929.	Increase.		Decrease.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
Total Area (excluding Water)	19,069,503	19,069,503	..	..	..	..
Mountain and Heath Land used for Grazing (*b*)	9,500,576	9,573,114	..	..	72,538	0·8
Total Acreage under Crops and Grass..	4,640,718	4,652,988	..	..	12,270	0·3
Arable Land	3,071,815	3,105,478	..	..	33,663	1·1
Permanent Grass — For Hay	170,710	167,868	2,842	1·7	..	..
Permanent Grass — Not for Hay	1,398,193	1,379,642	18,551	1·3	..	..
Permanent Grass — Total	1,568,903	1,547,510	21,393	1·4	..	.
Wheat	53,927	50,730	3,197	6·3	..	..
Barley (including Bere)	106,571	100,549	6,022	6·0	..	..
Oats	861,712	888,731	..	..	27,019	3·0
Mixed Grain	1,060	1,169	..	..	109	9·3
Rye..	3,111	2,833	278	9·8	..	..
Beans (to be harvested as Corn)	3,356	2,833	523	18·5	..	..
Peas	357	387	..	..	30	7·8
Potatoes	123,358	144,770	..	..	21,412	14·8
Turnips and Swedes	372,696	371,273	1,423	0·4	..	..
Mangolds	1,181	1,204	..	..	23	1·9
Sugar Beet	1,668	618	1,050	171·3	..	..
Cabbage	4,734	4,132	602	14·6	..	..
Rape	10,656	8,820	1,836	20·8	..	..
Vetches or Tares, for Seed	100	121	..	..	21	17·4
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	10,712	10,980	..	..	268	2·4
Carrots	350	351	..	..	1	0·3
Onions	129	159	..	.	30	18·9
Small Fruit	8,233	7,927	306	3·9	..	..
Rye-grass and other Rotation Grasses and Clover — For Hay	410,491	408,322	2,169	0·5	..	..
Rye-grass and other Rotation Grasses and Clover — Not for Hay ..	1,088,777	1,091,414	..	..	2,637	0·2
Rye-grass and other Rotation Grasses and Clover — Total	1,499,268	1,499,736	..	..	468	0·03
Other Crops	3,079	2,671	408	15·3	..	..
Bare Fallow	5,562	5,489	73	1·3	..	..
Orchards (*a*)	1,004	1,019	..	..	15	1·5

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	120,231	123,357	..	..	3,126	2·5
Unbroken Horses (including Stallions). — One year and above ..	14,578	14,969	..	..	391	2·6
Unbroken Horses (including Stallions). — Under one year ..	5,590	5,494	96	1·7	..	..
Total	140,399	143,820	..	..	3,421	2·4
Other Horses	15,917	17,185	..	..	1,268	7·4
Total of Horses	156,316	161,005	..	..	4,689	2·9
Cows in Milk	350,781	355,631	..	..	4,850	1·4
Cows in Calf, but not in Milk..	46,895	46,771	124	0·3	..	..
Heifers in Calf	55,381	51,339	4,042	7·9	..	..
Bulls being used for Service	17,147	16,991	156	0·9	..	..
Other Cattle :—Two years and above ..	216,762	215,578	1,184	0·5	..	..
,, ,, One year and under two ..	304,602	301,234	3,368	1·1	..	..
,, ,, Under one year	244,431	245,401	..	..	970	0·4
Total of Cattle (*c*)	1,235,999	1,232,945	3,054	0·2	..	..
Ewes kept for Breeding	3,325,234	3,281,087	44,147	1·3	..	..
Rams to be used for Service in 1930	92,313	90,525	1,788	2·0	..	..
Other Sheep :—One year and above . ..	969,732	974,877	..	..	5,145	0·5
,, ,, Under one year	3,262,272	3,209,031	53,241	1·7	..	..
Total of Sheep (*c*)	7,649,551	7,555,520	94,081	1·2	..	..
Sows kept for Breeding	17,900	16,130	1,770	11·0	..	..
Boars being used for Service	1,773	1,812	..	..	39	2·2
Other Pigs	123,596	124,275	..	..	679	0·5
Total of Pigs	143,269	142,217	1,052	0·7	..	..

(*a*) Any Crop or Grass grown in Orchards is also returned under its proper heading.
(*b*) Includes land on Deer Forests used for grazings.
(*c*) Including cattle and sheep grazed on Deer Forests.

ACREAGE under WHEAT, BARLEY (including BERE) and OATS in each COUNTY on 4th June 1930, with COMPARISON for 1929.

COUNTIES.	Wheat.		Barley (including Bere).		Oats	
	1930.	1929.	1930.	1929.	1930.	1929.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	13	10	11,695	9,580	172,948	179,080
ANGUS	11,924	10,737	11,672	10,967	55,218	56,795
ARGYLL	2	...	760	771	14,335	14,767
AYR	722	674	26	21	36,403	35,834
BANFF	12	...	6,859	6,168	42,599	44,410
BERWICK	1,537	1,604	10,079	10,337	24,696	26,146
BUTE	4	3	12	6	4,294	4,240
CAITHNESS ...	...	...	403	455	25,704	26,677
CLACKMANNAN ...	213	162	51	88	2,659	2,657
DUMBARTON ...	323	314	5	...	6,127	6,176
DUMFRIES ...	39	20	31	39	33,582	33,507
EAST LOTHIAN ...	5,282	4,736	12,339	11,945	13,970	15,086
FIFE	11,493	11,237	9,782	9,892	40,576	42,717
INVERNESS ...	22	33	3,741	3,550	28,085	29,715
KINCARDINE ...	1,055	868	5,867	5,358	30,529	31,374
KINROSS	275	194	109	110	6,091	6,224
KIRKCUDBRIGHT...	57	18	47	27	19,056	19,258
LANARK	1,545	1,750	76	41	34,262	34,333
MIDLOTHIAN ...	4,855	4,783	3,173	2,976	19,250	19,359
MORAY	588	661	9,160	7,785	21,986	24,009
NAIRN	...	...	1,977	1,705	5,732	6,508
ORKNEY	...	...	2,982	3,397	29,870	30,406
PEEBLES	2	2	28	33	5,274	5,353
PERTH	7,475	6,800	1,843	1,651	61,435	63,825
RENFREW ...	1,360	1,386	19	...	8,548	8,826
ROSS & CROMARTY	767	535	5,908	5,486	30,864	32,473
ROXBURGH ...	950	804	5,552	5,910	21,415	21,982
SELKIRK	...	...	72	141	3,124	3,103
SHETLAND ...	...	...	504	516	5,863	5,952
STIRLING	1,143	1,091	311	314	16,046	16,514
SUTHERLAND ...	...	...	194	199	6,600	6,794
WEST LOTHIAN ...	2,255	2,308	1,218	1,033	10,047	10,185
WIGTOWN... ...	14	...	76	48	24,524	24,446
TOTAL ...	53,927	50,730	106,571	100,549	861,712	888,731

ACREAGE under POTATOES, TURNIPS and SWEDES and SUGAR BEET in each COUNTY on 4th June 1930, with COMPARISON for 1929.

COUNTIES.	Potatoes.		Turnips and Swedes.		Sugar Beet.	
	1930.	1929.	1930.	1929.	1930.	1929.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN	7,003	7,759	77,227	77,306	2	2
ANGUS	15,818	19,382	28,829	28,745	138	53
ARGYLL	2,520	2,632	4,632	4,644	...	...
AYR	7,552	8,674	6,803	6,727	1	1
BANFF	1,671	1,891	18,568	18,675	11	5
BERWICK	1,995	2,315	18,539	18,466	33	30
BUTE	902	970	1,183	1,210	...	...
CAITHNESS	1,056	1,082	9,999	10,243	...	...
CLACKMANNAN	317	372	743	704	...	...
DUMBARTON	1,754	2,109	1,361	1,311	...	...
DUMFRIES	2,544	3,066	14,144	13,812	...	...
EAST LOTHIAN	7,141	8,473	11,678	11,814	84	54
FIFE	13,908	16,876	19,408	20,102	1,248	379
INVERNESS	4,621	4,855	8,406	8,472	...	...
KINCARDINE	3,433	4,154	14,807	14,655	...	3
KINROSS	920	1,193	2,278	2,159	3	...
KIRKCUDBRIGHT	1,196	1,367	8,527	8,348	...	...
LANARK	5,055	6,122	9,116	8,930	...	...
MIDLOTHIAN	5,506	6,486	9,029	8,924	11	11
MORAY	1,501	1,704	12,835	12,774	14	11
NAIRN	232	259	3,609	3,578	...	...
ORKNEY	1,989	2,177	12,357	12,457	...	...
PEEBLES	289	358	2,488	2,467	...	...
PERTH	14,804	18,299	22,734	22,177	88	34
RENFREW	2,652	3,222	1,896	1,858	...	...
ROSS & CROMARTY	6,583	7,176	13,067	13,187	...	...
ROXBURGH	1,010	1,218	15,360	15,098	3	4
SELKIRK	117	135	1,899	1,784	...	...
SHETLAND	1,911	1,966	981	981	...	...
STIRLING	2,660	3,292	3,511	3,447	...	...
SUTHERLAND	984	1,023	2,411	2,465	...	...
WEST LOTHIAN	2,207	2,589	3,092	3,018	...	...
WIGTOWN	1,507	1,574	11,179	10,735	27	26
TOTAL	123,358	144,770	372,696	371,273	1,663	613

ACREAGE under RYE-GRASS and other ROTATION GRASSES and CLOVER, and under PERMANENT GRASS in each COUNTY on 4th June 1930, with COMPARISON for 1929.

COUNTIES.	Rye-grass and other Rotation Grasses and Clover.				Permanent Grass.			
	For Hay.		Not for Hay.		For Hay.		Not for Hay.	
	1930.	1929.	1930.	1929.	1930.	1929.	1930.	1929.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
ABERDEEN ...	51,481	51,387	247,958	243,982	2,412	1,755	47,489	48,242
ANGUS	24,002	23,425	60,851	60,435	1,969	1,406	30,149	28,991
ARGYLL	11,946	11,592	15,511	15,610	15,560	14,964	49,817	50,864
AYR	26,991	26,697	46,243	45,942	22,424	22,190	155,933	157,469
BANFF	10,039	10,425	61,649	61,814	559	356	13,896	12,169
BERWICK ...	11,963	12,221	50,839	52,026	2,348	2,548	64,328	61,235
BUTE	2,416	2,264	5,698	6,103	460	501	10,326	9,479
CAITHNESS ...	9,671	9,908	31,701	31,008	585	728	24,232	23,128
CLACKMANNAN	1,337	1,212	1,281	1,418	1,296	1,305	6,809	6,768
DUMBARTON ...	5,328	5,015	4,469	5,018	2,288	2,502	22.759	22,290
DUMFRIES ...	20,714	20,228	46,202	49,269	19,150	19,493	104,305	101,994
EAST LOTHIAN	9,443	9,129	17,494	16,655	1,479	1,484	26,338	26,018
FIFE	26,769	25,645	29,390	29,053	4,894	5,060	76,633	74,386
INVERNESS ...	12,190	11,918	22,908	23,280	9,699	8,715	57,335	55,960
KINCARDINE ...	12,641	13,054	35,684	35,684	458	291	11,910	11,448
KINROSS ...	2,840	2,917	6,625	7,882	726	538	11,956	12,297
KIRCUDBRIGHT	10,964	11,170	40,329	40,619	13,053	14,375	85,797	84,595
LANARK ...	30,438	30,345	31,986	33,519	14,136	13,621	107,443	107,042
MIDLOTHIAN ...	10,765	10,810	17,173	16,692	2,144	1,898	42,354	42,631
MORAY	5,889	5,856	35,475	35,046	483	394	7,959	8,012
NAIRN	1,840	1,646	9,060	9,236	92	96	2,400	2,025
ORKNEY ...	11,094	11,316	32,699	31,475	1,224	1,294	15,249	15,094
PEEBLES ..	2,469	2,389	9,436	9,597	1,289	1,474	29,076	28,730
PERTH	32,950	32,880	59,795	58,972	11,958	11,787	99,624	97,988
RENFREW ...	8,122	8,210	5,891	6,362	7,189	6,413	43,075	43,778
ROSS AND CROMARTY ...	13,021	12,935	36,049	35,276	3,927	3,328	26,569	26,076
ROXBURGH ...	10,425	10,459	49,015	48,527	7,782	7,923	61,352	61,443
SELKIRK ...	1,713	1,535	6,408	7,237	1,930	1,989	14,570	14,034
SHETLAND ...	1,577	1,562	531	528	2,074	2,002	11,186	11,815
STIRLING ...	10,364	10,696	9,547	9,814	8,356	8,389	55,351	54,152
SUTHERLAND ...	4,456	4,553	5,702	6,219	1,504	1,607	8,819	7,763
WEST LOTHIAN	6,724	6,478	4,370	4,892	997	1,355	22,340	21,857
WIGTOWN ...	7,909	8,445	50,808	52,224	6,265	6,082	50,814	49,869
TOTAL ...	410,491	408,322	1,088,777	1,091,414	170,710	167,868	1,398,193	1,379,642

Number of Horses, Cattle, Sheep and Pigs in each County on 4th June 1930, with Comparison for 1929.

Counties.	Horses.*		Cattle.†		Sheep.†		Pigs.	
	1930.	1929.	1930.	1929.	1930.	1929.	1930.	1929.
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*
†Aberdeen ...	22,279	22,652	183,926	181,770	377,920	343,695	18,308	17,508
†Angus	7,348	7,678	52,972	50,100	209,393	194,757	6,947	6,093
†Argyll ...	4,299	4,325	50,981	54,483	711,218	733,233	3,312	3,058
Ayr	7,061	7,112	109,886	111,154	394,804	388,644	8,822	9,448
†Banff	6,616	6,663	43,691	43,661	103,066	95,601	5,406	4,740
Berwick ...	3,614	3,734	27,580	25,451	394,667	391,566	3,678	3,744
Bute	948	964	9,096	8,822	42,470	42,623	511	494
†Caithness ...	4,383	4,421	19,796	20,535	195,638	187,697	1,615	1,313
Clackmannan	478	474	3,939	4,005	13,459	12,833	283	318
†Dumbarton ...	1,215	1,290	12,892	12,732	68,838	67,696	944	695
Dumfries ...	5,280	5,355	68,447	68,999	573,032	575,774	8,114	8,424
East Lothian	2,837	2,896	17,043	15,485	166,300	159,302	2,974	4,220
Fife	6,949	7,322	47,931	46,495	147,274	134,587	6,235	5,152
†Inverness ...	6,289	6,363	45,311	47,892	505,748	511,019	1,755	1,514
†Kincardine ...	3,709	3,817	28,699	27,573	71,889	62,890	2,807	2,379
Kinross ...	847	878	6,131	5,711	36,990	33,084	548	607
†Kirkcudbright	3,579	3,694	58,126	58,708	391,230	387,662	10,760	11,023
Lanark ...	5,751	5,981	69,990	70,175	240,573	236,717	5,920	7,269
Midlothian ...	2,766	2,847	18,989	17,876	192,114	190,167	13,062	13,400
Moray	3,758	3,872	24,820	25,253	51,336	50,943	4,258	3,313
Nairn	1,051	1,063	7,044	7,180	14,572	13,654	658	627
Orkney ...	5,419	5,306	36,081	35,306	63,869	54,507	2,002	1,694
Peebles ...	699	717	7,191	7,194	211,844	211,985	760	825
†Perth	9,356	9,739	70,446	69,721	657,211	654,502	8,096	7,605
Renfrew ...	1,946	2,049	24,246	24,021	43,654	43,565	3,260	3,609
†Ross and Cromarty ...	5,542	5,722	37,448	39 411	323,913	325,875	3,131	2,563
Roxburgh ...	3,106	3,199	26,063	24,890	587,054	587,367	2,945	2,785
Selkirk ...	496	503	3,964	4,005	193,169	193,346	344	345
Shetland ...	1,952	2,114	10,672	11,440	160,876	165,728	167	155
Stirling ...	3,133	3,179	32,517	32,274	122,175	121,095	2,064	1,963
†Sutherland ...	1,733	1,768	8,642	9,246	218,977	226,026	468	500
West Lothian	1,684	1,709	12,527	11,855	24,699	22,790	1,533	1,507
Wigtown ...	4,276	4,414	58,912	59,522	139,579	134,590	11,582	13,332
Total ...	140,399	143,820	1,235,999	1,232,945	7,649,551	7,555,520	143,269	142,217

* Horses used for agricultural purposes, mares for breeding, and unbroken horses (including Stallions). "Other Horses" on agricultural holdings are not included; the total for these in Scotland is given in the summary table on p. 116.

† Including cattle and sheep grazed on Deer Forests.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1930.

COUNTY AND DISTRICT OF COUNTY.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		* Horses	† Cattle.	† Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*No.*	*No.*	*No.*	*No.*
ABERDEEN	Aberdeen	..	3,385	17,584	1,679	9,173	..	7,301	26,397	207	4,153	2,567	21,577	19,780	4,102
	Alford	..	421	15,387	292	7,295	..	5,064	21,596	224	6,986	1,969	16,072	54,546	899
	Deer	8	1,426	39,167	1,982	15,963	..	12,573	50,725	605	9,219	4,969	41,497	63,410	4,249
	Deeside	..	1,093	14,454	469	6,819	..	5,549	19,262	161	5,312	1,988	15,303	57,041	1,335
	Ellon	5	1,453	25,401	851	11,559	..	7,830	39,462	271	4,456	2,871	27,782	57,443	2,050
	Garioch	..	1,550	22,267	600	10,169	2	5,783	31,457	468	6,594	2,908	24,424	34,048	1,836
	Huntly	..	521	13,423	359	5,654	..	2,533	22,882	413	6,932	1,812	12,369	51,631	1,155
	Turriff	..	1,846	25,265	771	10,595	..	4,848	36,177	63	3,837	3,195	24,902	40,026	2,682
ANGUS	Arbroath	3,113	4,032	10,025	3,651	6,139	41	5,069	10,558	365	3,613	1,530	10,173	11,916	1,277
	Brechin	2,731	4,131	17,931	3,637	9,115	20	7,450	20,155	427	7,801	2,184	15,933	76,137	1,840
	Dundee	3,217	1,343	10,153	4,109	5,430	20	4,711	10,417	223	4,746	1,465	10,849	22,931	1,830
	Forfar	2,863	2,166	17,109	4,421	8,145	57	6,782	19,721	954	13,989	2,169	16,017	98,359	2,000
ARGYLL	Ardnamurchan	..	3	370	206	53	..	514	166	1,223	1,251	136	2,588	57,249	54
	Cowal	..	..	1,144	190	411	..	996	594	1,456	6,685	288	3,909	120,986	102
	Islay	..	7	3,480	479	1,076	..	2,982	3,453	1,575	13,671	876	9,067	68,987	464
	Kintyre	2	217	4,397	356	1,931	..	1,916	8,904	1,892	11,428	1,129	13,339	124,448	1,855
	Lorn	..	..	1,710	502	493	..	2,214	1,062	4,006	6,332	636	8,393	170,687	261
	Mid-Argyll	..	..	1,439	288	446	..	1,843	965	2,907	6,807	468	6,266	98,672	335
	Mull	..	533	1,795	499	222	..	1,481	427	2,501	4,143	766	7,419	70,189	241
AYR	Ayr	128	9	9,799	1,465	1,740	1	7,531	11,558	6,685	42,349	1,788	28,750	115,375	2,386
	Carrick	20	17	8,462	3,158	2,764	..	5,405	12,502	3,859	34,350	1,825	23,923	198,471	2,718
	Kilmarnock	284	..	9,067	962	1,081	..	7,501	11,210	6,371	42,266	1,738	31,092	36,166	2,446
	Northern	290	..	9,055	1,967	1,218	..	6,554	10,973	5,509	36,968	1,710	26,121	44,792	1,272
BANFF	Banff	12	6,126	24,473	1,222	11,463	11	5,940	35,179	212	3,388	3,895	27,964	36,079	3 924
	Keith	..	733	18,126	449	7,105	..	4,099	26,470	347	10,508	2,721	15,727	66,987	1,482
BERWICK	Eastern	464	3,824	7,701	880	6,098	22	3,912	16,720	532	18,871	1,234	9,091	106,604	1,280
	Middle	892	5,245	8,647	778	7,154	5	5,204	13,658	879	24,484	1,423	11,154	138,739	1,783
	Western	181	1,010	8,348	337	5,287	6	2,847	20,461	937	20,973	957	7,335	149,324	615
BUTE	Arran	..	2	2,039	525	406	..	1,165	2,365	239	5,234	503	4,257	32,708	258
	Bute and Cumbrae	4	10	2,255	377	777	.	1,251	3,333	221	5,092	445	4,839	9,762	253
CAITHNESS (not divided)		..	403	25,704	1,056	9,999	..	9,671	31,701	585	24,232	4,383	19,796	195,638	1,615
CLACKMANNAN (not divided)		213	51	2,659	317	743	..	1,337	1,281	1,296	6,809	478	3,939	13,459	283
DUMBARTON	Eastern	250	5	3,162	941	623	..	2,305	2,339	1,240	9,428	595	6,006	12,171	769
	Western	73	..	2,965	813	738	..	2,523	2,130	1,048	13,331	620	6,886	56,667	175

* See Note on p. 120.

† Including Stock grazed on Deer Forests.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1930.

COUNTY AND DISTRICT OF COUNTY.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		* Horses	† Cattle.	† Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	No.	No.	No.	No.
DUMFRIES	Annan	6	..	10,994	831	4,628	..	6,322	13,247	3,291	17,910	1,537	16,183	57,512	1,830
	Dumfries	31	11	8,124	824	3,274	..	4,368	11,437	2,169	16,066	1,144	14,029	60,404	2,386
	Langholm	..	3	2,043	137	923	..	1,530	2,598	2,981	8,461	427	4,835	122,208	302
	Lockerbie	2	17	7,319	435	3,228	..	4,726	11,781	5,700	27,216	1,256	18,118	147,845	1,225
	Thornhill	..	..	5,102	317	2,091	..	3,768	6,839	5,009	34,652	916	15,282	185,063	2,371
EAST LOTHIAN	Eastern	1,538	4,993	4,504	3,080	4,401	22	3,181	7,364	442	9,638	1,047	5,732	78,092	731
	Western	3,744	7,346	9,466	4,061	7,277	62	6,262	10,130	1,037	16,700	1,790	11,311	88,208	2,243
FIFE	Cupar	3,805	3,341	13,323	5,206	6,902	516	7,611	13,165	784	16,919	2,084	13,809	53,142	1,786
	Dunfermline	1,074	410	7,077	1,416	2,375	22	4,509	3,202	1,304	23,246	1,155	9,029	30,888	1,113
	Kirkcaldy	2,343	1,620	9,413	3,008	4,008	146	6,509	5,960	1,351	15,125	1,650	10,729	24,040	1,718
	St. Andrews	4,271	4,381	10,763	4,278	6,123	564	8,140	7,063	1,455	21,343	2,060	14,364	39,204	1,618
INVERNESS	Inverness	5	1,496	6,601	380	3,927	..	2,889	11,258	186	5,002	1,212	7,403	42,759	957
	Aird	17	103	5,177	378	2,366	..	2,846	5,695	342	5,891	868	5,840	42,147	549
	Badenoch	..	20	3,442	135	1,418	..	2,007	4,098	1,050	10,623	613	4,402	98,576	146
	Lochaber	..	4	889	362	182	..	1,259	405	2,031	2,790	345	4,569	131,394	83
	Skye	..	..	4,953	1,238	381	..	1,943	948	3,712	5,370	855	9,684	125,372	11
	Harris, N. & S. Uist	..	2,118	7,023	2,128	132	..	1,246	504	2,378	27,659	2,396	13,413	65,500	9
KINCARDINE	Laurencekirk	385	850	9,617	1,065	4,060	..	3,221	10,424	34	2,733	935	7,332	23,061	805
	Lower Deeside	..	579	3,648	755	1,749	..	1,845	3,552	93	967	533	3,569	2,889	645
	St Cyrus	542	1,435	5,694	707	2,899	..	2,378	6,087	7	2,513	685	4,493	16,532	528
	Stonehaven	128	1,876	7,913	676	3,997	..	3,564	9,907	284	4,075	980	8,751	20,467	551
	Upper Deeside	..	1,127	3,657	230	2,102	..	1,633	5,714	40	1,622	576	4,554	8,940	278
KINROSS (not divided)		275	109	6,091	920	2,278	3	2,840	6,625	726	11,956	847	6,131	36,990	548
KIRKCUDBRIGHT	Eastern	22	27	7,775	800	3,321	..	4,531	14,093	3,686	28,524	1,361	19,654	77,201	4,183
	Northern	..	..	1,521	109	632	..	947	2,631	2,741	10,886	385	5,244	144,223	636
	Southern	35	20	7,994	220	3,824	..	4,414	20,827	4,987	35,507	1,509	27,351	87,795	5,643
	Western	..	..	1,766	67	750	..	1,072	2,728	1,639	10,880	324	5,877	82,011	298
LANARK	Lower Ward	565	4	3,443	1,265	541	..	2,847	1,474	2,181	6,777	587	4,472	1,179	3,109
	Middle Ward	935	40	15,163	2,044	3,033	..	15,808	10,799	6,691	53,303	2,735	36,248	33,932	1,847
	Upper Ward	45	32	15,656	1,746	5,542	..	11,783	19,713	5,264	47,363	2,429	29,270	205,462	964
MID-LOTHIAN	Calder	1,319	327	5,744	1,555	1,725	..	3,591	2,018	548	13,446	771	5,892	38,895	2,768
	Gala-Water	241	849	4,876	321	3,343	..	1,672	10,787	629	15,405	590	4,611	103,708	336
	Lasswade	1,528	1,642	5,593	1,367	2,822	11	3,501	3,800	571	9,717	859	5,267	41,101	2,090
	Suburban	1,767	355	3,037	1,763	1,139	..	2,001	568	396	3,786	546	3,219	8,410	7,968
MORAY (not divided)		588	9,160	21,986	1,501	12,835	14	5,889	35,475	483	7,959	3,758	24,820	51,336	4,258
NAIRN (not divided)		..	1,977	5,732	232	3,609	..	1,840	9,060	92	2,400	1,051	7,044	14,572	658

* See Note on p. 120.

† Including stock grazed on Deer Forests.

ACREAGE of CROPS and NUMBER of LIVE STOCK in each COUNTY DISTRICT of SCOTLAND on 4th June 1930.

COUNTY AND DISTRICT OF COUNTY.		Wheat.	Barley (including Bere).	Oats.	Potatoes.	Turnips and Swedes.	Sugar Beet.	Rye-grass and other Rotation Grasses & Clover.		Permanent Grass.		* Horses	† Cattle.	† Sheep.	Pigs.
								For Hay.	Not for Hay.	For Hay.	Not for Hay.				
		Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*No.*	*No.*	*No.*	*No.*
ORKNEY	Mainland	..	849	16,237	1,059	6,255	..	6,262	18,086	361	8.543	2,960	19,104	80,117	1,053
	North Isles	..	1,855	9,232	639	4,411	..	3,285	10,638	776	5,226	1,753	12,238	25,550	704
	S. Ronaldshay & Walls	..	278	4,401	291	1,691	..	1,547	3,975	87	1,480	706	4,739	8,202	245
PEEBLES (not divided)		2	28	5,274	289	2,488	..	2,469	9,436	1,289	29,076	699	7,191	211,844	760
PERTH	Blairgowrie	2,665	675	14,414	4,810	5,976	45	7,089	15,185	349	14,889	1,957	13,965	64,380	2,105
	Central	571	131	13,594	2,808	4,510	8	7,034	14,049	1,556	19,787	2,013	13,965	132,308	1,557
	Highland	4	60	5,709	609	2,286	..	4,333	6,635	2,284	14,255	1,076	8,398	203,771	1,215
	Perth	3,955	832	18,833	5,305	7,873	35	9,832	16,949	2,546	30,095	2,706	22,059	77,024	2,605
	Western	280	145	8,885	1,277	2,089	..	4,662	6,977	5,223	20,598	1,604	12,059	179,728	614
RENFREW	First or Upper	710	1	3,570	936	814	..	3,564	1,722	4,357	22,253	841	11,705	19,682	1,883
	Second or Lower ..	650	18	4,978	1,716	1,082	..	4,558	4,169	2,832	20,822	1,105	12,541	23,972	1,377
ROSS & CROMARTY	Black Isle	77	2,262	6,273	650	3,786	..	3,190	9,666	280	2,377	1,165	6,284	18,301	967
	Easter Ross	657	1,257	8,677	1,520	4,854	..	3,968	14,136	475	6,962	1,512	9,263	82,404	1,489
	Mid Ross	33	679	8,309	604	3,837	.	3,995	11,597	558	6,916	1,403	8,948	83,914	617
	S.-W. and Western ..	..	6	1,621	564	179	..	1,448	475	1,576	2,788	310	3,678	71,577	48
	Lewis	..	1,704	5,984	3,245	411	..	420	175	1,038	7,526	1,152	9,275	67,717	10
ROXBURGH	Hawick & Liddesdale ..	1	2	2,655	119	1,542	..	1,447	5,711	3,651	12,169	464	5,686	183,702	291
	Jedburgh	100	1,000	6,539	217	4,442	..	3,035	15,393	1,571	19,902	967	7,516	168,124	616
	Kelso	709	3,983	7,458	529	6,369	3	4,030	17,290	1,406	14,769	1,128	8,541	155,663	1,473
	Melrose	140	567	4,763	145	3,007	..	1,913	10,621	1,154	14,512	547	4,320	79,565	565
SELKIRK (not divided)		..	72	3,124	117	1,899	..	1,713	6,408	1,930	14,570	496	3,964	193,169	344
SHETLAND	Mainland	..	495	4,803	1,530	857	..	1,168	448	1,478	7,950	1,296	8,145	123,893	144
	North Isles	..	9	1,060	381	124	..	409	83	596	3,236	656	2,527	36,983	23
STIRLING	Central	618	104	6,337	1,096	1,489	..	3,427	4,073	4,578	18,890	1,340	13,122	43,879	744
	Eastern	443	193	5,547	732	1,025	..	3,618	2,680	2,324	16,756	985	9,093	7,221	646
	Western	82	14	4,162	832	997	..	3,319	2,794	1,454	19,705	808	10,302	71,075	674
SUTHERLAND (not divided)		..	194	6,600	984	2,411	..	4,456	5,702	1,504	8,819	1,733	8,642	218,977	468
WEST LOTHIAN	Bathgate	258	139	5,091	568	1,208	..	3,374	2,150	502	12,661	835	6,540	8,914	395
	Linlithgow	1,997	1,079	4,956	1,639	1,884	..	3,350	2,220	495	9,679	849	5,987	15,785	1,138
WIGTOWN	Machars	14	48	9,022	306	3,928	27	4,658	17,337	4,635	34,450	1,873	27,347	76,139	3,194
	Rhins	..	28	15,502	1,201	7,251	..	3,251	33,471	1,630	16,364	2,408	31,565	63,440	8,388

* See Note on p. 120.

† Including stock grazed on Deer Forests.

DEPARTMENT OF AGRICULTURE FOR SCOTLAND,
EDINBURGH, 12*th December* 1930.

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THE TRAINING OF WOMEN FOR COUNTRY LIFE.

CRAIBSTONE SCHOOL OF RURAL DOMESTIC SCIENCE.

ALEX. M'CALLUM, M.A., LL.B.

EVER since the days of John Knox and his parish school system Scotland has had justification for pride in her scheme of education and in its results, and even to-day we may claim that our general education, elementary and secondary, is well-organised and highly efficient. But the tradition in Scottish education has been preparation for the university and for professional careers, and the requirements of the " lad o' pairts " have dominated the curricula of our schools down to the present time. There have indeed been modifications in recent years, but it is true to say that there are still branches of education to which sufficient attention is not given; and of these certainly not the least important is the training of women for rural life.

When one thinks of the part woman plays in the rural household, and especially in the household situated on the small farm, one realises how much of the well-being and happiness of the rural community depends upon the manner in which the wives and mothers perform their functions. To the household on the small farm the woman is mother and nurse, housekeeper, cook, laundrymaid and seamstress; on the farm she is dairymaid, poultrymaid and stock attendant; such accounts as are kept are usually in her charge; she is household treasurer; and nowadays also it is recognised that she has social and political responsibilities to fulfil. The comfort, the health, the well-being, and the happiness of the family are largely in her hands, and properly regarded, therefore, her function in the social life of the countryside is of the first importance.

Do we sufficiently realise this importance, and do we make any real attempt to provide adequate training for the young country woman who is to undertake so much responsibility?

We are not without examples in other countries of a fuller recognition of women's influence on the general welfare, and of the need for special training to secure that their influence will be rightly directed.

The lead in this recognition, and in the provision of facilities for training was taken by Belgium. In that country attention began to be given to the education of farm women about 1888, and in 1890 the State made grants to six schools which were giving courses in rural domestic economy. By 1913 these schools or sections had increased to eighteen, and two Convent Training Colleges for teachers were devoting a post-graduate year to agricultural training. But, naturally, the situation in Belgium after the war gave a great stimulus to this type of education. Her statesmen saw that the rehabilitation of their country depended on the regeneration of the rural home, and that in turn hinged on the character, capacity and knowledge of the home-maker.

There is now accordingly in operation a fully developed system of training in house and farm management on three levels—the highest represented in the residential training colleges, the middle in residential schools, and the lowest in non-residential courses arranged at elementary schools or in other ways.

The aim of the training is the turning out of good managers in all that pertains to family life and work on the small farm. This is interpreted in the widest sense, covering on the one hand all the responsibility of the wife and mother for the physical and moral upbringing of the children, and even for some supervision of their earlier intellectual education; for the material comfort of the household, for the brightness and happiness of family life, for the artistic and decorative treatment of the house; and, on the other hand, taking in her duties as partner in the farming business, involving a competent knowledge of dairying, poultry-keeping, stock-rearing, gardening and account keeping.

Perhaps the outstanding features of these Belgian courses are the emphasis they lay upon housecraft and mothercraft, and the importance they attach to organisation, planning and method in work—the actual timing of operations and the gradual building up of daily and weekly routine.

The training is essentially practical, and the equipment of the schools is so planned as to ensure to the pupils full opportunity of carrying through the various operations and processes, each on her own responsibility. In some of the schools for example one or two tiny children are the objects of care to each of the students in turn. Several of the schools have model farmhouses and outbuildings, specially constructed to show the arrangements under which household and farm work can be most conveniently carried out, and where each student takes charge for a full round of weekly duty.

Besides the numerous short courses given in many outlying districts, there are in Belgium nine provincial schools of rural domestic economy with a one year curriculum, fifteen residential schools giving a two year course, and three schools of the highest grade with a three year course, mainly intended for training teachers for the lower grade schools and courses.

Similar importance is attached to this branch of education in other European countries. Thus in Norway there are 68 schools of Rural Household Management and a State Training College for women teachers in that subject. Sweden has 38 schools of Rural Economy for Women giving courses of from three to six months' duration. And to come nearer home, Southern Ireland has nine private residential schools of Rural Domestic Economy recognised and assisted by the State, a State Training school of Domestic Economy, and the well-known Munster Institute, also State-administered, mainly devoted to specialist training in dairying and poultry-keeping, but providing also instruction in domestic science and practice. Northern Ireland has several residential schools giving short courses of this sort, and one technical institution—the Ulster Dairy School—which is run on the same lines as the Munster Institute.

Thanks to the initiative of the Governors of the North of Scotland College of Agriculture, Scotland has one such institution—the School of Rural Domestic Economy at Craibstone.

In the year 1909 the Governors of that College were on the outlook for a farm to be used for experimental and demonstrational purposes, and the estate of Craibstone was brought to their notice. Situated in the parish of Newhills and the county of Aberdeen, the property consisted of about 700 acres, of which 474 were arable, 44 pasture, 218 wood lands and 27 waste, together with the mansion house and outbuildings and a fine old walled garden. The first proposal was merely to lease the Home Farm of about 138 acres; but as the mansion house was standing empty, the further suggestion was made to use it either as a school for girls after the pattern of the Munster School in Ireland or as a hostel for agricultural students. At that time the estate belonged to the Trustees and Managers of Alexander Scott's Hospital, Huntly, whose powers of dealing with the property were limited by the terms of the Trust. On the other hand, to alter and equip the place for the purposes of the College meant so heavy an expenditure that it could be justified only by ownership of the subjects. After prolonged negotiations the Trustees and the Governors jointly promoted a Provisional Order to obtain authority for the Trustees to sell, and to invest the proceeds in trust securities. The Order was duly obtained, the purchase price—£17,890—was paid over, and the ownership of Craibstone became vested in the Governors of the College at Whitsunday 1914. Interim possession of the mansion house and Home Farm had been arranged for since Martinmas 1910, but nothing was done beyond necessary farm work until the purchase was completed.

The securing of funds for the acquisition and equipment of Craibstone is another story.

Soon after the establishment of the Development Commission in 1909 an arrangement was come to between them and the Scottish Education Department whereby £60,000 was set aside from the Development Fund towards the extension and improvement of agricultural education in Scotland. Under that arrangement the funds for Craibstone—purchase and equipment—were provided out of this £60,000 as to one half only, the remainder to be furnished one quarter from the Education (Scotland) Fund and one quarter from local contributions. The local moneys were obtained mainly from county authorities in the College province.

The outbreak of war held up the development of the scheme of utilisation of the estate and mansion house, only necessary routine work being carried on. From October 1918 to October 1921 Craibstone was used by the Ministry of Labour as a residential centre for training ex-service men, and 176 trainees passed through courses intended to fit them for employment in agriculture. Later, on the proposal of the Ministry, a short course for women was given in conjunction with a course in cookery, &c., at the Aberdeen College of Domestic Science, one half of the women attending at either centre alternately. At Craibstone, instruction and practical training were given in milking, butter-making and cheese-making, feeding and management of dairy cows, and poultry-keeping.

When more normal conditions permitted the College Governors once more to consider the establishment at Craibstone of a school for rural women, they were fortunate in being able to take over from the Joint Committee on Animal Nutrition the building which had been erected on Craibstone Estate just before the war to house the research staff working under that Committee. That body acquired ground of their own, and there erected the laboratories and other buildings now known as the Rowett Institute. Their first building at Craibstone was converted into dairying and laundry premises for the School, and at the same time the mansion house was adapted and equipped partly as a hostel and partly as teaching rooms for the domestic training; sufficient poultry plant to make a good instructional unit was provided; the Home Farm gave facilities for practical instruction in milking, butter and cheese making, calf-rearing and pig-keeping; the gardens were made available for training in horticulture; and the apiary provided opportunity for gaining familiarity with bees. It may indeed be claimed for Craibstone School that the advantages it possesses for practical work in training girls for country life are quite exceptionally good. The situation is convenient and accessible; it is at the same time sufficiently isolated in country surroundings to be quiet and retired; the policies are well-wooded and picturesque, and the whole conditions are healthful and pleasant. The aim of the School as stated in the prospectus is "to provide for girls who have already received a satisfactory general education, special training in the various duties undertaken by women in country districts, and generally to qualify them to carry out efficiently

CRAIBSTONE HOUSE.

FARM, DAIRY AND LAUNDRY BUILDINGS, AND APIARY.

BUTTERMAKING CLASS.

POULTRY CLASS.

the work of rural life." The curriculum accordingly embraces sections dealing with

Home-making,
Needlework,
Cookery,
Laundry work,
Poultry-keeping,
Dairying,
Animal husbandry,
Gardening,
Bee-keeping.

While a certain amount of theoretical instruction is necessarily involved, the training is kept as definitely practical as possible, all the girls in turn spending a certain time in the operations and processes of each of these sections. But, again, all the practical training is closely related to underlying principles, and is used to arouse the interest of the students in such practical work and to emphasise its importance and dignity. The students are led to seek out knowledge for themselves, and individual reading and thinking about their work are encouraged.

One of the most beneficial sides of the training at Craibstone does not appear in the syllabus: that is the use of leisure. General reading is stimulated; the presentation of simple plays is attempted; home-crafts, such as rug-making, simple upholstery, embroidery, cane weaving, room decoration, and so forth are encouraged; and games, both outdoor and indoor, are regularly played.

To overtake all this varied scheme of education there is a resident staff of lady superintendent and three assistants, and several visiting teachers. The lady superintendent is responsible for the home-making and needlework sections as well as for general organisation and supervision; one assistant teacher deals with cookery and laundry, another with poultry-keeping, and a third with dairying; while the visiting staff give special instruction in animal husbandry, gardening, and bee-keeping.

At present the course is one of from five to six months, and this permits of two classes of students being admitted each year. The times of entering are January and July, and although, as is obvious, there must be some slight difference in the arrangement of subjects in the two seasons, nevertheless the same curriculum is covered by both classes. This arrangement is still to some extent provisional and experimental. As was pointed out above, similar schools in Belgium have courses extending to two and three years, and it is obvious that a lengthened course at Craibstone would enable the subjects to be more thoroughly learnt. Such a development, however, depends on the extent of the demand for this type of training. The hostel accommodation at Craibstone at present is sufficient for thirty students, and only once or twice since the School was opened have there been more than that number offering themselves for enrolment.

Looking to the character and value of the training available, the Governors have been in expectation of the demand growing more rapidly, and they have plans prepared for doubling the hostel accommodation. Increased numbers would lead to increased staff and to greater ease in organisation, so that it might be possible to contemplate extension of the course for at anyrate some proportion of the students. The content of the course is likewise somewhat fluid, being gradually evolved from a careful study of the needs of the adolescent girl who is to live her life in country conditions.

Even as it is, however, the course has been shown to be one of great interest and benefit to the students. In the sessions already held, girls have attended from all the northern counties, from Orkney and Shetland and the Hebrides, and from certain other counties in the south, and there is abundant evidence both of the benefits derived by them from their training and of their enjoyment of the amenities of the School life. Nearly all the Education Authorities in the northern area give one or more bursaries annually to enable approved students to take the course, and it is hoped that as the School becomes better known this useful procedure will be extended. There is no reason why Education Committees in the south-east and south-west should not follow suit, so that the School may come to be regarded as a regular part of the educational equipment of the country providing a natural complementary course for girls with rural careers before them. As the courses in advanced divisions of country schools come to be developed, it is surely not too much to expect that the curriculum for girls will have in view the life-work they will be called on to do, and will provide in more elementary form the kind of training now given at Craibstone. Then it would be even more appropriate to expect to find the institution regarded as a sort of finishing school for the country woman.

For two or three years past useful short courses of three weeks' duration have been given at Craibstone for teachers in rural schools and have been much appreciated by those who have attended. This is a practice that might quite well be applied in other directions. It is conceivable that even shorter courses on specific subjects might be arranged from time to time, to be attended by farmers' wives and daughters, members of Women's Institutes, or other women with particular interests.

[*Note.*—Full information about the School and the terms and conditions of entry are contained in the Prospectus, copies of which may be obtained from the Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen.]

RECLAMATION AND CULTIVATION OF PEAT LAND IN LEWIS.—Part II.

W. G. OGG, M.A., B.Sc., Ph.D., and JONATHAN GARST, B.S.A.,
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ANGUS MACLEOD, B.Sc.,
North of Scotland College of Agriculture.

AN account by two of the present writers of the problems of land improvement in Lewis, the establishment of the Macaulay Demonstration Farm, and the preliminary results obtained on it, has been published in a previous issue of this Journal.[1] The initial work was carried out under the supervision of Sir Robert Greig, who at Mr. Macaulay's request agreed to be responsible for the scheme until such time as other arrangements could be made. Last year the farm became part of the new Macaulay Institute for Soil Research, and is now being worked in conjunction with the laboratories and experimental grounds at Craigiebuckler, near Aberdeen, and with the co-operation of the North of Scotland College of Agriculture.

Progress during 1930.—The development of the Demonstration Farm and the experiments on the reclamation of peat and skinned land begun in the previous year were continued in 1930. The area under crops has been extended considerably, and a further area has been cultivated and prepared for cropping. Live stock have been purchased, and satisfactory progress has been made with milk and egg production.

A comparison of the areas cropped in 1929 and 1930 will afford some indication of the progress made :—

	1929.	*1930.*
Rye and grass seeds	7·75 acres.	–
Oats	0·25 ,,	7·9 acres.
Mashlum and grass seeds ...	0·30 ,,	5·40 ,,
Grass cut for hay	– ,,	7·80 ,,
Pasture improvement	– ,,	2·0 ,,
Potatoes	0·60 ,,	1·75 ,,
Vegetables, &c.	0·10 ,,	0·25 ,,
	9·0 ,,	25·1 ,,

A further area of 23 acres was cultivated, and 5 acres were sown with winter oats in the late autumn. A total area of approximately 46 acres had been cultivated up to the autumn of 1930.

Climatic Conditions during the Year.—The rainfall for 1930 was 43·73 inches at Stornoway and 34·03 inches at Butt of Lewis. These figures are below the average, and from February to September the weather was unusually dry and favourable for work on peat land. In February the rainfall was well under one inch, but January had a rainfall of nearly seven inches and October

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[1] *Scottish Journal of Agriculture*, Vol. XIII, No. 2, 1930.

7¼ inches. The dry weather in the spring months enabled considerable progress to be made with cultivation, but the very wet autumn interfered with harvesting operations.

Notes on Native Vegetation.—The character of the native vegetation has an important bearing on the question of pasture improvement, and in September 1930 Dr. J. W. Gregor, of the Scottish Plant Breeding Station, visited Lewis and made a rapid survey of the vegetation in certain parts of the island. The following account is based on Dr. Gregor's notes :—

Wet uncultivated moorland on the Macaulay Farm.—An area south of the stream which runs through the farm was examined. The peat is deep and wet, and may be taken as representative of much of the peat land in Lewis. The vegetation is typical of very wet moorland, and consists mainly of sedges and one grass, *Molinia cœrulea.* Here and there where conditions are slightly less moist, matgrass occurs to a small extent, and a sparse growth of heather is found, especially where the peat is thin.

The most abundant grass is *Molinia cœrulea*, a perennial moorland species, which is distributed uniformly throughout the area. At the time the examination was made the plants were only a few inches high, and no flower stems were seen except along the banks of an open drain, where ripe seeds had developed. Dr. Gregor suggests that it might be possible to isolate types of this species which would be of economic importance. It is desirable to find grasses which could be used in the preliminary stages of reclamation work, and which could be replaced later if necessary by grasses of higher agricultural value. *Molinia cœrulea* appears to be the grass which thrives best on this moor under natural conditions, and if even a moderately useful grazing type could be isolated, it might be an inexpensive means of bringing about a preliminary improvement of the common pasture.

On the areas in process of reclamation various grasses such as annual meadow grass, smooth stalked meadow grass, Yorkshire fog, crested dogstail, and various forms of agrostis are found, and associated with them typical seashore plants. These have been introduced with the shell sand used for liming the land. Dr. Gregor points out that Yorkshire fog grows vigorously on the grass plots which have been sown on the farm, and suggests that this might also be used in mixtures for preliminary pastures, but merely as a temporary expedient.

Coastal vegetation.—The coastal vegetation covers a very small area compared with the moorland, but all the "townships" of the island, except one, are situated on the coast, and the coastal pastures are, therefore, of considerable importance. On the coastal areas the following grasses occur :—Yorkshire fog, crested dogstail, sweet vernal grass, fescues, sea matweed, couch grass, species of bent, cocksfoot, perennial ryegrass, meadow grasses (*Poa sp.*) Various leguminous plants are abundant in many places, e.g. red clover, white clover, tufted vetch, bird's foot trefoil and kidney vetch. There is also a whole series of miscellaneous plants of less agricultural importance.

Proceeding inland from the narrow coastal strip to the moorland, the vegetation gradually loses its coastal character and the moorland species become more and more abundant. In certain areas two distinct types of coastal vegetation can be seen, viz. a comparatively tall type extending some distance inland on the windblown sand, and a close green turf which may extend some distance below high tide level.

The coastal vegetation is infinitely superior to the moorland vegetation for grazing, and it could no doubt be made still better by suitable treatment. The conditions on the seashore and on the moor are so utterly different, however, that there is no hope of producing a coastal vegetation on the moorland, although several of the species found on the shore would flourish on moorland which had been drained, limed and manured.

Draining and Cultivation.—Trials with cultivation and drainage machinery were carried out during the year. The "Lanz" rotary tiller, described in the previous article, has been used for all the cultivation on the farm. It thoroughly macerates the moor turf and prepares a seed bed in one operation, but the machine at the farm is easily bogged in a wet moor and requires a fairly smooth surface. In many places, therefore, considerable preliminary preparation is required before it can be used.

A caterpillar tractor made with specially wide tracks for soft land was purchased in September, and with this machine it has been found possible to work on undrained moor typical of the softest land on the island. The tractor has been on the land during the winter when the moors were very wet, and while, in a few instances, it has broken through the surface and failed to get sufficient traction to pull an implement, it has never been difficult to get it out again when bogged. During the drier months it will probably travel satisfactorily over the moorland without much preliminary drainage. It will also negotiate much rougher land than will a wheel tractor, but the problem of finding a suitable tool to pull behind it has still to be solved. Many of the peat areas in Lewis are considerably eroded, and are intersected with small gullies, whilst in other places peat has been cut for fuel in a haphazard fashion, leaving a very broken and irregular surface. Experiments were carried on during the autumn, and so far the most satisfactory tool has been a German mouldboard moor plough. This is carried on very broad wheels which do not sink into the moor, and it has a wide cut of about 20 inches, so that a furrow slice of turf up to 10 inches thick remains inverted. With this implement and a caterpillar tractor considerable areas of rough moor land can be ploughed without previous preparation.

The deep ploughing in some places brings up a fairly well decomposed peat, which it is hoped will dry out to make a surface soil which will be firm and easy to work.

A heavy disc plough was also tried on the moor. It cut and turned the surface satisfactorily, and would work on rocky land where a finely pointed and sharpened mouldboard plough would not be suitable, but in preliminary trials the standard wheels were not wide enough to carry the weight of the implement on wet moor land.

Ploughing in any case is rather expensive, and experiments with the rotary tiller have shown that very deep cultivation is not essential for the establishment of pasture. Further trials were therefore carried out with the object of finding an implement which, at a low cost, would break the turf sufficiently to prepare the land for pasture. A heavy disc harrow failed to turn the surface, and the cuts it made quickly closed up. An ordinary land cultivator with wide teeth cut the sub-surface without disturbing the turf, except where the shanks cut a narrow line. So far no satisfactory implement has been found, but implements are being constructed for further experiment.

Cropping.—*Hay and Pasture.*—Field No. 6 (7¾ acres), sown in July 1929 with rye and five different grass seed mixtures, and cross-dressed with different amounts of lime and shell sand (see *Scottish Journal of Agriculture*, XIII, 121 (1930)), was cut for hay in June. The rye was a sparse crop, but except on the area which received neither lime nor shell sand the growth of grasses and clovers was remarkably vigorous, and excellent hay was obtained. Owing to the presence of spots which had been wet and boggy during the previous winter, and to inequalities in the depth of cultivation, the crop was somewhat uneven in places, but on the good areas the yield and quality was at least equal to the best in Lewis outside the farm. There were no weighing facilities, but the total yield was estimated at 8 to 9 tons of dried hay. Part of the crop was used for green feed for the cows early in June, and after the hay was removed there was an excellent aftermath which provided grazing for six cows for about 2½ months.

The field is to be used for pasture, and the effects of the different dressings of lime, the comparative values of the different grass seed mixtures, and the behaviour and lasting qualities of the various grasses and clovers will be studied. It is too soon yet to draw conclusions, but already several points of interest have been observed.

The crop on the " no-lime " plot was decidedly inferior to that on the rest of the area. This plot received a small amount of calcium in the phosphatic manure, but neither lime nor shell sand. It contained practically no clover, and even the rye and grasses made a poor and thin growth. There was no obvious difference between the plots receiving various dressings of lime and shell sand, and it would appear that shell sand is as suitable as lime, and that pasture can be established with a dressing of even half a ton of lime or an equivalent amount of shell sand. It is important to determine how long these small dressings will suffice.

At the present stage the pasture obtained from all the grass seed mixtures seems to be satisfactory, but differences may appear later. Perennial ryegrass, although abundant, does not appear to be thriving, but rough and smooth stalked meadow grasses, timothy and cocksfoot look healthy and the clovers are doing well. In a random sample of the hay, perennial ryegrass and the two meadow grasses were found to be most abundant, followed by timothy, Yorkshire fog (not sown), meadow fescue and cocksfoot.

The growth of a good sole of grass very perceptibly dries the moor, and when adjacent areas were too soft to carry an animal the cows were able to graze the field without damaging the surface.

The results obtained during the past year afford further evidence that with suitable treatment excellent pasture can be established on acid peat land, such as is found in Lewis, and further work will be directed towards lowering costs and obtaining the most suitable varieties of grasses and clovers.

Oats and Mashlum.—These two crops may be considered under one heading, as the mashlum consisted mainly of the addition of Italian rye grass, alsike and red clover to the oats. The total area under these crops in 1930 amounted to 13¼ acres, of which there were 2 acres on Field 6, 3·4 acres on Field 1, 5·9 acres on Field 2, and 2 acres on an unreclaimed area near the southern boundary of the farm.

The two acres on Field 6 consisted of a portion near the farm buildings on which the late Lord Leverhulme had commenced cultivation experiments, and on which a certain amount of peat had been cut for fuel, leaving deep trenches. The surface was so irregular that it was impossible to sow out this part in 1929, when the rest of the field was laid down to grass. In 1930 the peat cuttings were filled in, the surface roughly levelled, and the area cultivated with the Lanz machine as well as the uneven ground would allow. This land slopes down to the small stream which runs through the farm, and the peat on the north side of this stream is shallower and drier than most of the peat on the south side, but even on the north side it becomes fairly deep in the hollow near the stream. The two acres received a dressing of 8 tons shell sand per acre and a fertiliser mixture consisting of 2 cwt. sulphate of ammonia, 2 cwt. 30 per cent. potash salts, 2 cwt. superphosphate and 3 cwt. ground mineral phosphate, and were sown with sandy oats and a grass seed mixture.

Fields 1 and 2 lie south of the dividing stream, and consist chiefly of deep peat of the Scirpus type in a very wet and raw condition. The drainage of this area leaves much to be desired, and it was not possible to cultivate the whole of these fields. The portion cropped amounted to 9¼ acres, and owing to the softness of the ground and the wet weather at the time of cultivation this was gone over only once with a Lanz cultivator. It was not possible in the circumstances to go to a depth of more than a few inches, and some parts were entirely missed. Under these conditions the best results were not expected, but it was desirable to put in a crop in order to hasten the decomposition of the peat and to help to dry the land. The same amounts of shell sand and fertilisers were applied as described above for Field 6.

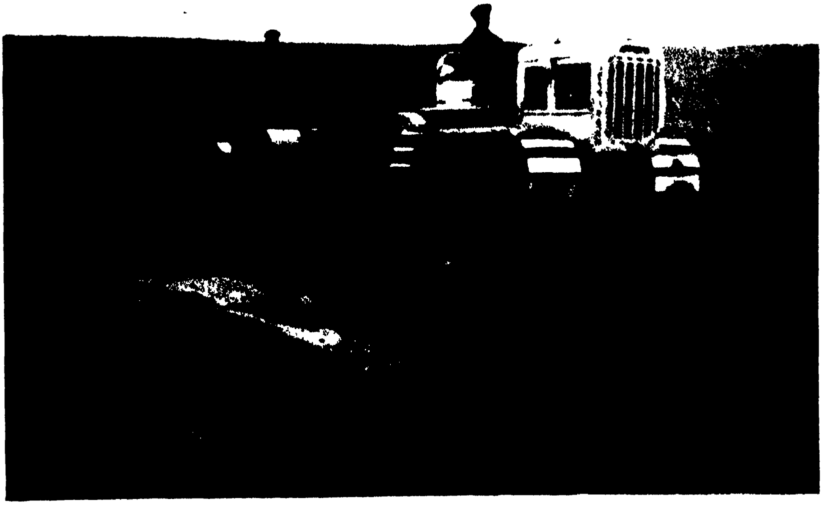
The best results were obtained on an area of 3·4 acres in Field 1 sown on 30th April with a mixture of 4½ bushels of Sandy oats, 20 lb. Italian rye grass, 4½ lb. alsike and 3 lb. broad-leaved red clover per acre. Growth was somewhat patchy, as might be expected, but generally a strong healthy crop, standing fully 5 feet high in places, was produced. The straw was excellent, and was much relished by the stock. The grain did not ripen fully, but it was estimated from the growing crop that this area would have yielded about 40 bushels per acre, and the average yield last year in Lewis was officially estimated at 27 bushels per acre.

Oats alone were grown on Field 2, but the results were not as good as in Field 1. Part of the area (2·9 acres) was sown on 7th May, and a further part (3 acres) on 15th May. Both Sandy and Potato oats were tried in each section. Rather dry surface conditions at the time of sowing and difficulty in covering the seed, resulting in a great deal of damage by rooks, led to a poor braird. The Potato oats did not germinate well and had to be resown on 13th June, and as this was too late to allow the crop to ripen, it was cut for green feed.

Since pot experiments had shown that oats could be grown with only a dressing of fertilisers, it was decided to try mashlum in an area which had been neither drained nor limed. This was carried out on 2 acres of fairly firm peat near the southern boundary of the farm. The area was cultivated with the Lanz machine, and treated with the same fertiliser mixture as the rest of the oats. The results, however, were disappointing. The clover failed, and on considerable portions the oats and grass were also very poor, but on about two-thirds of the area fairly good grass was obtained.

The harvesting of crops, in the early stages of the reclamation of extremely wet and raw peat, such as is found on the Macaulay Farm, is not an easy matter. Owing to the unevenness and softness of the ground a mower could not be used, and the crops had to be cut by the scythe. Most of the oats and mashlum were cut towards the end of September, and during the very wet spell of weather which followed, considerable difficulty was experienced in drying the crop on the soft wet surface of the newly reclaimed peat. On similar land in Scandinavia the sheaves are raised off the ground on wooden spikes or frames, but as timber is scarce in Lewis, the same end was achieved by stretching wires on fence posts. This considerably facilitated the drying of the crop. Even the bringing of the crop to the steading presented difficulties, as owing to the heavy rains the intervening ground had become too soft and boggy for a tractor. These difficulties could be overcome to a large extent by growing

WET ERODED PEAT LAND, SHOWING UNEVEN NATURE OF SURFACE.



CATERPILLAR TRACTOR DRAWING MOOR PLOUGH.

MOOR PLOUGH.

WORK DONE BY MOOR PLOUG

a considerable proportion of the crop for silage and harvesting it much earlier, and arrangements are now being made for the erection of a small silo. Experiments will also be made with simple drying frames.

The mashlum sown in 1929 in Field 1 contained Italian rye grass, alsike and red clover, and as these came up well in the following year the plots were cut for hay. A considerable amount of rough stalked meadow grass was found to be present, although it was not sown.

Potatoes.—The success of the crop grown in 1929 with hand-made ridges encouraged the hope that a crop might be grown under less favourable conditions on the deeper and rather softer peat, and an area of 1¾ acres was selected on Field 1. This had been cultivated with the Lanz machine the previous summer, but not cropped, and the exposure to frost in winter and to winds in the abnormally dry spring had caused a well-pulverised and dry layer to form on the surface. Deep and thorough cultivation was not possible, however, on account of the uneven nature of the surface, and the wet condition underneath. A dressing of sand at the rate of 8 tons per acre was applied.

As the land was too soft for horses, and no suitable drilling implement for use with the tractor was available, it was decided to dibble-in the potatoes on the level, since hand ridging was considered to be too expensive. The same six manure mixtures were sown as were used the previous year, the surface was harrowed, and the setts were dibbled-in to a depth of 3 inches during the first week in May. The rains which followed, although not particularly heavy, rendered the ground very wet in places, and many of the setts rotted. Probably root development was retarded owing to the shallowness of the cultivated layer and the raw boggy nature of the peat below, and growth was very uneven throughout the field. The haulms had a yellow unhealthy appearance, and this must be attributed mainly to lack of drainage. There was an ample supply of fertilisers, but it is possible that owing to the system of working, the plants did not obtain the full advantage of this.

Only about 12 to 15 cwt. per acre of potatoes, and these mostly seed size and chats, were lifted. It is clear that on this type of raw peat land, which is liable to become waterlogged at times during the growing season, and on which cultivation is shallow, drills are essential. Trials will be made with drilling implements in 1931 if conditions are suitable.

Vegetables.—Cabbages, marrow-stem kale, Jerusalem artichokes, and broccoli were tried in small plots, but again, owing to the shallowness of tillage and the present raw nature of the peat below, growth was arrested rather early and the crops were light. The artichokes grew to a height of 4 ft. 6 ins., but only small tubers were formed. The cabbages were small but healthy and of excellent quality. Broccoli was planted in April in a specially selected plot of partly alluvial peat near the stream, but most of the plants went to seed. In addition, broccoli seed was sown in April, and transplanting was carried out in June. A good growth of stem and leaves was produced, but the plants did not reach the flower stage.

Vegetables will probably do much better when the land has been drained more thoroughly.

Dairying.—One of the main objects of the farm is to improve the cattle on the island and to increase the milk production. Four pure-bred tuberculin-tested Red Poll cows were purchased in May and two heifers a month or two later. In addition one bull and two quey calves are being reared.

A dual purpose breed is considered to have certain advantages for crofting conditions, such as are found in Lewis, and it is also desirable to have small animals on soft newly-reclaimed land. It is intended to test the suitability of other breeds later.

The cows have proved quite satisfactory, and were pastured last season on the new grass without damaging either themselves or the pasture. Since conditions appear to be favourable for the production of milk, of which a considerable amount is imported from the mainland, the number of cows will be increased during the present year. The milk is now being sold as ungraded T.T. milk, but the production of Certified or Grade A T.T. milk will be undertaken as soon as possible.

Poultry.—An attempt is being made to stimulate the poultry industry in Lewis, and Mr. T. B. Macaulay has provided funds for establishing breeding units in several different parts of the island. The breed selected as being the most suitable for Lewis conditions is Rhode Island Red. A 12-bird unit was set up at the farm at the end of the year, and it is intended to increase the stock to a hundred with a view to distributing sittings of eggs to crofters, and to demonstrating modern methods of egg production and poultry management.

Trees, Shrubs, &c.—The trees and shrubs have made growth where drainage was satisfactory, but in wet spots and in very exposed wind-swept situations the plants have suffered badly, and even the osiers have not done particularly well in the very wet corner of the farm in which they were planted.

There is much need for hedges and shelter belts on the island, and various plants are being tested for this purpose.

Experiment on Skinned Land.—The experiment begun in 1929 is being continued, and certain interesting results have been obtained. A plan of the experiment is given below, and shows the treatment received by each plot and the yields per acre of hay obtained. The whole area measures 28 by 38 yards, and is divided north and south into four strips or plots. Plot I was trenched, Plot II was dug, Plot III roughly levelled, and Plot IV was left uncultivated. The area was divided into 13 strips across these plots, and manured and limed as shown in Table I. The whole area was sown with grass and clover seeds.

The results indicate in general the importance of manures on this type of land. On the unmanured plots no crop of any kind

TABLE I.

Skinned Land Experiment. Yield per acre of Hay.

	I.			II.			III.			IV.			
	Trenched.			Dug.			Roughly levelled.			Uncultivated.			
	tons	cwt.	lb.	tons	cwt.	lb.	tons	cwt.	lb.	tons	cwt.	lb.	
Plot 1A.		*Nil.*			*Nil.*			*Nil.*			*Nil.*		No lime. No manure.
Plot 1B.		*Nil.*			*Nil.*			*Nil.*			*Nil.*		6 tons shell sand. No manure.
Plot 2A.	0	3	24	0	13	104		*Nil.*			*Nil.*		No lime. Half No. 1 mixture.
Plot 2B.	0	8	64	0	12	36		*Nil.*			*Nil.*		No lime. Full No. 1 mixture.
Plot 3A.	0	8	64	0	19	92	0	8	4		*Nil.*		6 tons shell sand + half No. 1 mixture.
Plot 3B.	1	19	72	1	5	80	0	9	12		*Nil.*		6 tons shell sand + full No. 1 mixture.
Plot 4A.	1	6	28	0	18	24	0	13	104		*Nil.*		6 tons shell sand + half No. 3 mixture.
Plot 4B.	1	14	32	1	14	92	0	17	76		*Nil.*		6 tons shell sand + full No. 3 mixture.
Plot 5A.	0	19	92	1	2	56	0	8	64		*Nil.*		30 cwt. lime + half No. 1 mixture.
Plot 5B.	1	19	72	1	14	92	1	1	48	0	3	24	30 cwt. lime + full No. 1 mixture.
Plot 6A.	3	9	72	1	19	12	2	17	96	2	2	36	6 tons sand + No. 10 mixture + seaweed.
Plot 6B.	4	7	96	2	19	52	3	9	72	2	17	96	6 tons sand + No. 10 mixture + dung.
Control		*Nil.*			*Nil.*			*Nil.*			*Nil.*		No lime. No. manure. No seeds.

No. 1 mixture (per acre):—
2 cwt. sulphate of ammonia.
4 cwt. 30 per cent. potash salts.
2 cwt. 18 per cent. superphosphate.
3 cwt. 34 per cent. ground mineral phosphate.

No. 3 mixture (per acre):—
2 cwt. sulphate of ammonia
4 cwt. 30 per cent. potash salts.
8 cwt. 18 per cent. basic slag.

No. 10 mixture (per acre):—
1 cwt. sulphate of ammonia.
3 cwt. 18 per cent. superphosphate.
4 cwt. ground mineral phosphate.

grew, but shell sand or lime, used in conjunction with manures, gave better yields than manures alone.

Comparing the half-dressings of manures with the full dressings, it is clear that the ground responds to fairly heavy manuring, the B Plots giving in nearly every case substantially higher yields than the A Plots, which received only half the quantities.

The superiority of the plots receiving organic manures was very plainly seen, and it appears that with shell sand or lime, and artificials, the response on roughly levelled and uncultivated land is not marked, but if organic manure is added good results are obtained. There are indications that it is advantageous to apply the phosphate as basic slag, at any rate on the roughly levelled land, but the results are not very conclusive.

The quality of the hay varied considerably and the best was obtained from the trenched plot—the other plots containing more of the rougher unsown grasses.

A subsequent examination of the pasture showed that the appearance and quality of the different plots were more or less in keeping with the results obtained from the hay crop.

The experiment is being continued and extended to include plots with different phosphates, fish refuse and the like, with a view to finding an inexpensive means of improving the extensive areas of this type of land.

THE SCOTTISH PLOUGH TEAM IN HISTORY.

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THE familiar Scottish plough team of the present day, consisting of a pair of big and active Clydesdales, seems to us a very obvious solution of the problem of the plough's draught. Yet it is of comparatively recent origin, and was arrived at only after many experiments and after a good deal of controversy. Two hundred years ago two-horse plough teams scarcely existed; a hundred and fifty years ago they were the exceptions rather than the rule; and up till the early part of last century there were leading authorities who favoured other possible solutions of the problem.

Adam Dickson, the first Scotsman to write a systematic treatise on farming (published in 1762), enumerates the various arrangements that were in use in his time. If we leave out those that were of a makeshift character, as well as those that were probably confined to England, and restrict ourselves to such as were established by custom in one part or another of Scotland, the list is as follows :—

Two horses abreast.
Three horses all abreast.
Three horses, two abreast and one before.
Four horses all abreast.
Four horses in pairs.
Six oxen in pairs.
Eight oxen in pairs.
Two oxen behind and two horses before.
Four oxen behind and two horses before, in pairs.
Four oxen behind and four horses before, in pairs.
Six oxen behind and two horses before, in pairs.

Even this list, long as it is, omits mention of the teams of ten and twelve oxen that were common in the north-eastern counties at the time in question.

Many of these teams seem absurdly large, but there are a number of circumstances that help to explain their size. For one thing, the animals composing the teams were often small and ill-fed, and consequently anything but powerful. The plough-horses in the Highlands and Islands were, according to Dr. Walker,[1] " sometimes only nine and seldom twelve hands high." Even in the lowlands, and after some improvements had been achieved, the horses were small by modern standards. As late as 1795 Robertson [2] described the typical farm horse of the Lothians as between 14½ and 15½ hands high. As regards cattle, if we judge by the carcase weights of mature and fed bullocks, the plough oxen of Aberdeen and Morayshire, during the eighteenth century, probably averaged no more than 4½ or 5 cwt. live weight. Also the plough was often a clumsy and ill-constructed implement, and its passage was often obstructed by stones or boggy patches in the land. Possibly in some cases the size of the team was a matter of vanity on the part of the farmer; the " twal owsen pleugh " of the north-eastern counties was regarded as the mark of a substantial farmer, and thus the full complement of cattle may sometimes have been maintained, as a matter of pride, where a lesser number would have sufficed.

The variety of teams in Dickson's day was probably much greater than would have been found in earlier times. Indeed, there would seem to be a distinct probability that the original arrangements were no more than two, and that all the others arose by processes of evolution or combination.

The Highland Plough and its Team.—One obviously very primitive type of plough survived in many parts of the Highlands and Hebrides until the beginning of the nineteenth century and is fully described, in closely similar terms, by a number of different writers. One of the fullest and best descriptions is that of Dr. Walker. This writer was Professor of Natural History in Edinburgh University, and at various times between 1760 and 1786 was employed by the General Assembly of the Church, and by the Commissioners of the Annexed Estates, to survey the Highlands and Islands. He made six separate tours in the area, and since he was a very accurate observer and an able writer his account of Highland agriculture [1] is of great interest. "The Highland plough," he says, "is a very singular and feeble instrument: its whole length is about 4 feet 7 inches. Like the plough used by the ancients, it has only one stilt or handle by which it is directed; a slight mouldboard is fastened to it with two leather straps and the sock and coulter are bound together at the point with a ring of iron. To this plough there are four horses yoked abreast; their traces are thongs of leather; the driver, with the reins fixed to a cross stick, walks before the horses backwards, and strikes them in the face to make them proceed forwards. The ploughman holding the stilt walks not behind but by the side of the plough, directing it with one hand; another man follows with a spade to lay down the turf that is torn off. The want of a proper mould board is the reason why the labour of this additional man is required to finish the furrow. In other places they have a plough similar to this, but with two stilts, which are almost erect, so that the man who holds the plough walks upright between them. All the work executed by this plough, which occupies four horses and three men, ought to be performed by one man and two horses."

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[1] **Walker**: *Economical History of the Hebrides and Highlands*, 1808.
[2] *Report on the Agriculture of Midlothian.*

One or two minor details may be added to this account. Of the four ponies, the one on the off side walked on the ploughed land, the second in the fur, and the other two on the unploughed land. Some descriptions omit mention of the cross stick in front of the ponies, and say that the driver held the four halters in one hand and his whip in the other. However, the arrangement always necessitated the driver's walking backwards. In some cases, where the sod was tough, the plough was preceded by another implement known as the ristle, consisting simply of a coulter attached to a frame.

This type of team was in use during the eighteenth century throughout the whole of the West and Central Highlands and in the Hebrides, but not (as will be shown later) in the low country round the Moray Firth. It was still remembered in Galloway at the end of the eighteenth century.[2] Also it was well known in Ireland. Arthur Young, in his Irish Tour, mentions it in several passages, sometimes in conjunction with other primitive agricultural practices that were common to the West Highlands of Scotland. Thus under Westport [3] he says: "They plough all with horses, four in a plough, directed by a man walking backwards, who, to make them move forward, strikes the beasts in the face"; and again [4] under Castle-Bar: "They have three customs which I must begin with; first, they harrow by the tail; item the fellow who leads the horses of a plough, walks backwards before them the whole day long, and in order to make them advance, strikes them in the face. Item they burn the corn in the straw, instead of threshing it." Yoking the harrow by the tail, and the making of graddan meal were well known West Highland practices.

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[1] *Economical History of the Hebrides and Highlands*, 1808.

[2] See *Old Statistical Account*, Parish of Kells, Kirkcudbright.

[3] *Tour in Ireland*, Vol. I. p 365.

[4] *Ibid.*, p. 350.

We may thus probably conclude that the plough team we have described was in use among the Gaels from very early times.

The Long Plough.—Very different from the old plough and plough team of the Highlands were those in use in the Eastern Lowland parts of Scotland. The plough was a much larger implement and was very heavily (if not always strongly) built. The total length was 14 or 15 feet; the beam and body were very long and the stilts very short as measured against a modern plough. The sock was without a feather and the mould board was a flat piece of wood. The original team consisted, there is good reason to suppose, of eight oxen, yoked two and two. "A yoke lay across the necks of each pair of oxen; and a 'bow,' consisting of a piece of ash, birch or willow, bent to the proper shape, surrounded each separate ox's neck. The points of the bows were stuck upward through the yoke and securely pinned in that position. A 'brecham' or pad of dried sprots, rushes, straw, &c., intervened between the neck of the ox and the bow to prevent friction in draught."[1] A long iron chain, called the soam, was attached to a staple on the right hand side of the beam of the plough, and ran forward between the cattle. It was attached directly to the yokes of the three leading pairs and to that of the last pair by means of a short chain of large links. The height of the soam at this point could thus be adjusted according to the depth of furrow required.

That eight was the original number of the ox-team seems very probable for several reasons. For one thing, a study of the Old Statistical Account will show that it was the commonest number and also nearly the average. Where the soil was strong and the cattle were small the team might indeed be increased to ten or twelve, but conversely, on light land or where food conditions were better, it was sometimes reduced to six. Again, there appear to be only eight distinctive names for the places in the team. The leading pair, which were of course the oldest and best trained oxen, were the *wyner* (off side) and the *on-wyner*. The second, which were the youngest pair, were the *steer draught* and the *on-steer-draught*. Third came the *throck-in-fur* and the *throck-on-land*, and finally the *fit-in-fur* and *fit-on-land*. Where the number was increased to ten, there was a pair of fore throcks and a pair of hind throcks; and where the total was twelve there were fore, mid and hind throcks. Finally the division of farm lands into ploughgates and oxengang was very common throughout eastern Scotland as far back as our records go, and there are always eight oxengang to the ploughgate. It has indeed sometimes been suggested that in England, where a similar arrangement existed, the actual team was of four oxen and that the cattle were changed at midday; but in Scotland there is no evidence that four oxen were used as a team until after the plough had undergone improvements, which happened in the eighteenth century.

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[1] Alexander: *Notes and Sketches of Northern Rural Life.*

The boundaries of the region into which the long ox-plough was introduced are a matter of some interest. Broadly speaking, this area was the eastern half of the country. We may gather from the Old Statistical Account that the line of division ran somewhere through Dumfriesshire and Lanarkshire to somewhere about Stirling. Thereafter it closely followed the "Highland Line" through Perthshire, Angus and South Western Aberdeenshire. Several of the ministers of Highland Line parishes—Doune, Logierait, Blairgowrie and Strathdon—mention the fact that the Highland plough was used in the one end and the long plough in the other end of their parishes. The territory of the long ox-plough also included the greater part of Banffshire, Moray, Nairn, the north-eastern corner of Inverness-shire and Easter Ross. In Caithness and Sutherland there was a peculiar state of affairs which will be mentioned later. Of course by the time that the Old Statistical Account was written oxen had largely been displaced by horses in the south-eastern area, but their general use was still remembered. Why the use of oxen never spread westwards—for example, into Ayrshire—is difficult to understand. Several Ayrshire ministers refer to the fact that there was no tradition of oxen ever having been used in the county, but none attempts to explain it.

The division indicated above appears to have applied to the earliest periods of which there are any written records. Thus in the early rentals that have been published—for example, those of Kelso Abbey, the Diocese of Glasgow, Coupar Angus Abbey, the Lordship of Huntly, &c.—the holdings of tenants upon east country estates are often stated in oxengang, but in connection with west country estates the word is never used. In Ayrshire and other counties of the west ploughgates are mentioned as old land divisions by several writers in the Old Statistical Account, but these ploughgates consisted of four horsegangs instead of eight oxengang.

There is no feature by which we can distinguish the long ox-plough of Eastern Scotland from that used in the Anglo-Saxon districts of England. The likeliest theory of its origin is that it was introduced into the south-east of Scotland by the Angles at the time when Berwickshire and the Lothians formed part of the Anglian Kingdom of Northumbria, and that it gradually spread northwards along the easter arable belt.

Turning now to the extreme north, it is well known that Shetland, Orkney, Caithness and part of Sutherland were colonised to a considerable extent by Norse immigrants during the eighth and ninth centuries. The early Celtic inhabitants, however, were neither exterminated nor driven out. It is worth while, therefore, to glance at the constitution of the plough-teams in this area. What we find, at the end of the eighteenth century, is a curious confusion of practice. The plough itself was a very small and light implement—one account speaks of the ploughman carrying it to the field on his shoulder; in some parishes it had one stilt and in others two. The usual number of draft animals was four, but these might be all ponies, or all cattle, or any mixture. Also they were yoked, in some districts, all abreast, and in others two and two. In fact nearly every possible arrangement seems to have occurred. There is one other curious departure from the practice of the east of Scotland; in the latter area oxen were used almost exclusively for ploughing, while the other operations of the farm—harrowing, carting, sledging and carrying—were done by horses. But in the north the farmer might have a plough team of ponies and use oxen for his carts and harrows.

Early Modifications.—A very common plough team in Fife and Angus during the latter half of the eighteenth century consisted of a pair of horses followed by two pairs of oxen. The horses were yoked by collars, traces and swingle tree to the end of the soam or plough chain, and the cattle by bows and wooden neck yokes in the manner already described. When this team began to be used the writer has not been able to discover. An early reference appears in the Sheriff Court Book of Fife [1] under the date 1520. The action was one of spuilzie, and the pursuers, Alexander Kincaid and Margaret Craig, his wife, of Pitscottie Wester, alleged that a certain James and Alexander Kinmount had, without order of law, taken from the said Alexander and Margaret "furth of thar pleugh in the said ground 1111 oxone and twa horse, price of the piece XLs. be thar estimacione."

Of the origin of this mixed team there would seem to be a simple explanation. In our very earliest Scottish rent-roll, that of Kelso Abbey, there is a reference to the stock of the Abbey's tenants on the farm of Redden. Each tenant held the ordinary allotment of a quarter of a ploughgate, and up till about the year 1290 the tenancy was steelbow, i.e. the Abbey provided seed-corn, food-corn, implements and work animals. The allotment to each tenant consisted of two oxen, one horse, three chalders of oats, six bolls of barley and three bolls of wheat.[2] The total resources of each ploughgate, in work animals, then amounted to eight oxen and four horses. The ploughgate was supposed, in legal theory, to extend to 104 Scots acres of arable land, but doubtless varied in size. Thus when there was other work for the horses to do, or when ploughing was not a pressing operation, the eight-oxen plough could be kept going, and the horses could be otherwise employed. In the spring, when ploughing became urgent work, two mixed teams could be provided and a second plough set agoing. This was a regular plan in the Carse of Gowrie as late as 1750. Autumn ploughing was done with eight oxen, and this team was started again in the spring. Meanwhile the horses were used for carrying grain to market, and in the spring for harrowing the oat land. As soon as the oat seed was in the soil the farmer turned to his bere ground, which was always given two spring ploughings in order to clean it. At this time the animals were rearranged in mixed teams, and the ploughing strength was doubled.

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[1] p. 203.

[2] Liber S. Marie de Calchou, p. xxxiv.

Although the south-western district never adopted oxen for farm work it did adopt the heavy strong plough and the long, or two-and-two, yoke. In this area six horses were used, yoked two and two, on the heavier land and in earlier times. With the increase in the size of horses during the seventeenth and eighteenth centuries the number was generally reduced to four, and this remained the standard until Small's plough, and the further improvement of the Clydesdale, made possible the final step.

The Great Controversy.—From about 1770 until 1810 a vast quantity of ink was spilt over the question whether horses or oxen were the more proper for plough work. Adam Dickson (1762) thought that the answer must depend on circumstances, but Arthur Young, in England, was a very strong partisan on the side of cattle, and most of the writers of his time took his view. Lord Kames devoted a dozen pages of his "Gentleman Farmer" (1776) to a statement of this side of the case. He starts by saying: "There is not in agriculture any other improvement that equals the using oxen instead of horses; they are equally tractable, and they are purchased and maintained at much less expense. As this improvement is obvious to the meanest capacity, one might expect to see every farmer greedily embracing it, as he would a feast after having been famished. Yet few stir. How is this to be accounted for? Men are led by custom in chains, and in instances without number are fettered against their interest,"—and so on. Wight, who was a practical farmer as well as a writer, advocates oxen in several passages of his book,[1] but he rather naively admits that he had been obliged to use horses himself, "having been overcome by the obstinacy of his servants." The agricultural writers convinced a fair number of landowner-farmers to set an example to their tenants by using oxen, but the tide had definitely set in the opposite direction. Wages rose and farm operations had to be speeded up. The new iron plough, strong yet light, could stand up to the faster work, and the two horse team saved a man. Also the public lost its taste for eight-year-old beef. The two-horse team soon came to be regarded as the ideal to be aimed at, and very quickly the native draft horse was bred big enough and strong enough to enable the ideal to be realised, even upon the heaviest of Scottish soils.

[1] *The Present State of Husbandry in Scotland*, Vol. II, 1778.

AGRICULTURAL SURVEYS.

(Continued.)

In the Journal for October 1930 a summary was given of the report on a parish in the Central Highlands. The present article deals with the reports on the other two Highland districts embraced in the surveys. The survey of the parishes in Sutherlandshire was carried out during the winter of 1929-30, while the survey of the Argyllshire parish was carried out at the end of April and the beginning of May 1930.

(1) TWO PARISHES IN SUTHERLANDSHIRE.

These parishes were selected as being typical of a large part of the north and west of Scotland, comprising crofter settlements of varying degrees of prosperity on the sea coast, and also privately occupied sheep farms. The crofters gain their livelihood partly from cultivating a little arable land, partly from the keeping of stock, principally sheep, and partly from subsidiary forms of employment. As the sea has for generations provided the chief means of subsidiary employment, convenient access to it has no doubt been an important factor in determining the situation of most of the settlements.

Area and Holdings.—The area of the two parishes surveyed is approximately 270,000 acres, or over 400 square miles. Of this area only about 1,000 acres are returned as arable land and 600 acres as permanent grass land. Of the remainder about 56 per cent. (or some 150,000 acres) is classified in the Annual Agricultural Returns as " mountain and heath land used for grazing," while the remaining 44 per cent. consists of deer forest (on parts of which stock are grazed), woodland, inland waters, &c. The Agricultural Returns show a total number of holdings of 272. Of these, 219 (or over 80 per cent.) are under 5 acres in extent, exclusive of mountain and heath land, 42 (or 15 per cent.) are between 5 and 15 acres, there being only 11 (or 4 per cent.) over 15 acres. The great bulk of the mountain and heath land is divided into 26 grazings, about 100,000 acres being occupied by ten individual holders and two sheep stock clubs, and 50,000 acres being occupied by fourteen common grazing committees, representing some 240 holders. These holders have on an average about 4 acres of arable and grass land with the right of grazing their sheep on common grazings equivalent to a little more than 200 acres per individual.

Arable and Grass Land.—As indicated above, the area of arable and grass land is very small compared with the extent of rough grazing land. Apart from small inland areas, usually adjoining the deer forests, the whole of the arable and grass land borders on the sea and varies considerably in character. On the more exposed parts of the seaboard, where the land is very rocky and steep, patches of the size of small allotments may be seen carved out amongst the rocks. In some other parts where the arable land is fairly level the nature of the soil, the heavy rainfall and the lack of adequate drainage tend to keep the ground waterlogged. In spite of the unpromising nature of the primeval soil, however, the arable land is wonderfully fertile, owing chiefly to the fact that the sea, by supplying seaweed and fish refuse, and the common grazings, by enabling large numbers of stock to be kept, have both contributed to its fertility. In one of the more sheltered districts the land overlies limestone, and for this reason seems to be more fertile than other parts. The soil varies from an alkaline or only very slightly acid condition, where it overlies limestone and is free from moss and peat, to a strongly acid condition, where it consists mainly of peat.

Mountain and Heath Land.—The rough grazing lies mainly at an altitude of less than 1,000 feet. At first sight large tracts of the land seem to consist of naked rock, but at close quarters one finds that there is a fair amount of mixed grazing interspersed among the rocks. Heather grows almost everywhere but is seldom luxuriant, and is usually associated with some of the hardier grasses, such as fescues. Where the rough grazing overlies limestone, and along the sides of streams, there is usually a fair amount of grass, principally fescues. Away from the sea there are considerable stretches of flow land where deer-hair grass and other plants which provide an early bite constitute the main vegetation. On certain of the softer parts of the grazing, which are exposed to winds off the sea, the moss is often undermined and tumbles in, leaving big holes which are usually full of water and dangerous to all classes of stock. The stock carried per acre is very light, working out at one adult sheep to about eight acres. The few cattle and horses kept have also access to the common grazings.

The reporters deal separately with sheep farms occupied by individuals and with the holdings and grazing lands of the crofting communities, and a summary of their reports can conveniently follow this classification.

(*a*) FARMS.

System of Sheep Management.—The only breed of sheep in the district is the Sutherlandshire Cheviot. On practically all the larger farms only a ewe stock with followers is carried, the number of ewes ranging to upwards of 2,700. The gimmers are not usually tupped, lambs being taken normally from the three, four and five-year old ewes. Casting takes place at five years of age. Ewes are tupped on the hill, with the exception in some cases of those kept for stock purposes, i.e. the breeding of rams; part of a hirsel may be fenced off and the stock ewes from that hirsel tupped there. In other instances the stock ewes from the whole of the farm are brought together at mating time. At this time, too, a special hirsel, or part of a hirsel, is sometimes kept for gimmers, but where no special enclosures are provided these have to be herded away from the ewes. On the larger farms the tups are bred on the farm, selected ewes being mated to specially bought in tups and the best of the tup lambs kept for breeding purposes. On the smaller farms tups are usually hired from other farms, and as in some cases only the second cut from these farms is obtainable, the quality of the stock may be adversely affected. Tups are usually kept for three or four years and then sold. On the best managed farms adequate precautions are taken to avoid in-breeding, careful records being kept of the breeding of all the tups.

The ewes are wintered on the hill, but those which are thin or not thriving are generally taken from the hill from time to time and given special treatment, and if necessary kept on the arable land until lambing time. Any neglect of ewes during the winter is reflected in an increased death-rate. On account of so little arable or grass land being attached to most of the farms, the majority of ewes are lambed on the hill, but in a few cases a fair proportion of the ewes, including all the thinner ones, are brought down for lambing to the arable land or to a good low-lying hirsel reserved for that purpose. On only the best managed farms does the percentage of lambs reach 90. In 1929, owing to the continuous spell of hard bare frost in the early spring, many ewes slipped their lambs and in some cases the percentage was below 70. The lambs are weaned about the beginning of August, when the tops of the wether lambs are sold off. On the better managed and well situated farms there is usually a considerable surplus of ewe lambs, thus allowing the best lambs to be retained.

On the majority of the larger farms all or nearly all the ewe hoggs are sent away for wintering to arable districts (mainly Ross-shire) at a cost of about 15*s*. to 16*s*. per head. On one or two farms, however, the larger proportion of the ewe hoggs is wintered at home on the arable and low ground; and in one case where most of the ewe hoggs were previously wintered away they are now all wintered at home at a considerable saving to the farmer. On this farm one hirsel is kept clear of sheep all summer and is used along with the arable and grass land of the farm for wintering purposes. On some of the smaller farms the ewe hoggs are wintered on the hill.

On the better managed farms the death-rate, including "black loss," does not under normal circumstances exceed 5 per cent. As a precautionary measure against braxy, particularly in the case of ewe hoggs wintered at home, the inoculation treatment, with serum obtained from the Animal Diseases Research Association, is being adopted with apparent success.

Arable and Grass Land.—On most of the larger farms there is a fair extent of arable land, from one to two pairs of horses being kept. On most of the smaller farms, however, the arable land is comparable in size and working to that of a croft or has been laid down to permanent pasture. The tendency is to put more land down to pasture.

A few cattle are generally kept, mainly for milk, the calves being sold when two or three weeks old. On two farms, however, herds of about 20 cows are kept, in one case mainly Aberdeen Angus and in the other mainly Galloways, an Aberdeen Angus bull being used in both cases. The breeding cows and younger cattle are housed in courts or covered pens and run out to grass all winter. They get few or no turnips, but are given straw and a little hay and cake. Most of the turnips are needed for wintering tups and other sheep.

Financial Aspect.—According to the estimates made by the reporters, the financial results as between different farms vary considerably. On the best managed and best situated farms the income per head of ewe stock in a good year amounts to almost £2, being made up as follows :—

	s.	*d.*
·4 wether lamb at 32*s*.	12	10
·1 ewe lamb at 26*s*.	2	7
·31 cast ewe at 50*s*.	15	6
6 lb. wool at 1*s*. 4*d*.	8	0
Tups (sales and hires) and skins	0	4
	39	3

The total cash expenditure calculated on the same basis is given by the reporters as follows :—

	s.	*d.*
Rent	4	0
Wages	6	0
Wintering, including expenditure on low ground	4	0
Dipping	0	9
Marketing	1	0
Various : purchase stock tups, fencing, draining, &c.	2	6
	18	3

On the average farm, possessing little or no arable land or good low ground pasture, the figures would more probably be as follows :—

	s.	*d.*
Income—		
Wether lamb	10	0
Cast ewe	12	0
Wool, &c.	7	6
	29	6
Expenditure—		
Rent	3	0
Wages	6	0
Wintering	5	6
Dipping, marketing, carriage of wool, purchase of stock tups, fencing, draining, &c.	3	6
	18	0

(It should be remembered that the above calculations are based on the prices current at the time of the survey.)

It will thus be seen that on the very best managed and best situated farms a balance of 21*s*. per ewe is brought out, while on the poorer farms the balance is more likely to amount to about 11*s*. 6*d*. per ewe. This balance is required to meet interest on capital, cost of management, and also risk of possible loss of capital through falling prices, a serious matter in recent years.

In considering the differences in results the reporters refer specially to the advantages which may accrue to a farmer who has a fair extent of arable land or good low lying grass land attached to his farm. In Sutherland, unfortunately, the average sheep farm has little or no arable land. One advantage derived from the possession of a sufficient stretch of arable or grass land is that the ewe hoggs, or a considerable proportion of them, can be wintered at home. Another advantage, and one which has more important and far-reaching effects, is that a fair proportion of the lambing ewes, including all the thinner ones, can be taken down to the low ground and lambed there. As a result a higher lambing percentage is likely to be obtained, and the normal death-rate among both ewes and lambs is much lower than where most of the ewes must be lambed on the hill. This in itself increases the farmer's income, as more sheep and lambs are available for sale, but a further important result is that where ewe lambs are available for sale the poorer lambs are usually disposed of. The selling of ewe lambs is possible, the reporters state, only where the lambing percentage is over 80 and the death-rate all over is less than 10 per cent. The quality of the stock is thus maintained or improved, and the enhanced reputation of the stock is reflected in the better prices obtained.

As might be expected also, the reporters found that on the better farms draining is being systematically carried out, but on some of the others, where the financial results are not so encouraging, the drains had not been cleaned for many years. From the point of view of improvement of the grazing, heather burning is not so necessary in these parishes as in most other parts of Scotland and is not extensively practised. In most cases the hills are not fenced.

(*b*) Crofting Settlements.

The crofters' holdings are grouped together in townships consisting of from 5 to over 20 holdings. Each township or group of townships has a common grazing. The stocking of a croft varies somewhat in the different districts. In the case of one of the larger and more favourably situated groups of townships the stocking of a croft normally consists of a horse, one or two cows and a number of sheep, the average working out at about 21 ewes, 14 gimmers and maiden ewes, and about 19 lambs. The actual number of cattle and sheep kept on each holding is regulated by the rental. For example, for each £1 of rent a crofter is allowed to keep the equivalent of eleven sheep, exclusive of lambs, a cow being reckoned equal to six sheep. Over-stocking in individual cases may be allowed, but is charged for at the rate of 1*s*. 10*d*. per head of sheep, while under-stocking is compensated by dividing up the total amount received for over-stocking, each person under-stocked receiving his due proportion. The average stocking in other townships is somewhat less than that mentioned above, the number of sheep being about 13 to 14 ewes, 7 other adult sheep and 11 to 12 lambs. It is not always the practice to provide compensation for under-stocking. In many cases a horse is not kept; for instance, in one township of 16 holdings there was only one horse. In some townships the individual crofts are ring fenced but in other townships they are not. In many cases the greater part of the croft is under permanent grass, which is used for wintering the ewe hoggs and lambing the ewes and for providing hay for the cows and sheep. Summer grazing for the cattle, horses and sheep is provided by the common grazing, and sometimes by additional horse and cow parks rented in common.

Crops.—Generally speaking, no very definite rotation is followed; but the commonest in one parish is probably the five course rotation, viz. oats, roots, oats, two years' grass mown for hay. The cultivation for the various crops is usually clean and thorough. On the smaller crofts, where only small patches are worked, cultivation is frequently by spade.

Grain.—A small acreage of bere is still grown in some districts, but the main cereal crop is oats, a small area, averaging about an acre, being grown on practically every croft. The varieties are Sandy, Potato and " Small Black." In the more favoured districts, notwithstanding the late harvests, the grain is generally fit for seed purposes, but even in these districts it is considered desirable to buy in fresh seed every two or three years. In other districts seed requires to be purchased each year. The ground is not usually cultivated until well on into the spring so as to enable the sheep to get the full benefit of the pasture, the sowing taking place in April. Partly because the land is late in being ploughed and partly in order that the sheep may not eat the young braird before they go out to the hill, early sowing is not practised, though it would undoubtedly confer the twofold benefit of a larger and an earlier crop. Farmyard manure, seaweed, and occasionally artificial manures are applied to the land. The crops are generally fairly good, the average yield being estimated at about four quarters per acre. The grain is usually threshed by small hand or " hand and foot " mills. All the grain is used on the crofts for feeding purposes, none being milled or sold.

Roots.—In the more progressive districts practically every croft grows turnips, these being fed partly to cattle and partly to sheep. In other districts the quantity grown is very small, owing partly to the fact, apparently, that the individual crofts are not fenced, and the stock of the township have a free run over the arable land after the harvest is secured. The crofters growing turnips in these townships have consequently to store them. Greentop Yellow is the principal variety used. On some of the crofts "finger-and-toe" seems to give trouble. In addition to dung, artificial manures are usually applied, slag, bone meal, and a little sulphate of ammonia being commonly used.

Sufficient potatoes, generally from one-quarter to one-half acre per croft, are grown to supply household needs, and in some cases to give a small ration to sheep and cattle. The chief varieties are Kerr's Pink and Champion, but Arran Chief, Arran Victory, Edzell Blue and Kepplestone Kidney are also grown. Both dung and artificial manure are applied.

Grass.—On many crofts very little rotation grass is grown, hay being taken every year from the permanent pasture. Where there is rotation grass good seed mixtures are generally used. The grass land usually receives a dressing of dung, and on some crofts artificial manures such as slag, sulphate of ammonia and potash are applied after the ewes are put out to the common grazing in May. At this time the grass land is extremely bare, and partly for this reason the hay crops do not appear to be heavy.

Stock.—*Horses.*—These are mostly of the Garron breed. No horse breeding appears to have been done in recent years and the general tendency is to keep fewer horses, mainly on account of their constituting a considerable burden on the resources of the croft. Where they are kept they are used for general cultivation, carting manure and collecting seaweed, carting peats, transporting lobsters, and for work in connection with public road repair, as well as for hiring to crofters who have no horses.

Cattle.—The cows are mostly of good quality, but are only moderate milkers. Pedigreed Aberdeen Angus and Shorthorn bulls lent by the Department of Agriculture for Scotland have been used for many years, and most of the cows are the descendants of these bulls. Recently all the bulls used have been Aberdeen-Angus. The calves, except those required for breeding purposes, are usually sold young and command good prices. Any surplus milk not required for household purposes is made into cheese and butter for home use only.

In view of the nature of the holdings the management of the cattle appears to be very good. During the winter they are housed at night and get a feed of oat straw or hay and a little turnips or potatoes night and morning. They are put out to the common grazing during the day. Frequently food becomes scarce before the grazing season commences, principally owing to the heavy demands made by the hoggs and lambing ewes. A certain amount of concentrated feeding, mainly oats, is given on some holdings to young cattle and sometimes to cows.

The crofters are much handicapped by lack of market facilities. Thus when an animal other than a young calf has to be marketed the crofter must delay sending it away until a fairly large drove is leaving the district. The cattle have to walk to a station and are nearly a week on the road. In the more remote districts the total cost of marketing a calf comes to almost £1.

Sheep.—The management of the common grazings is vested in elected committees which deal with all points affecting the common grazing and the marketing of the sheep. Each crofter's sheep are distinguished by a different lug mark. Except in one township where the ewe lambs are wintered away from home, each crofter lambs his own ewes and winters his ewe lambs on his own croft. When the sheep are on the common grazing, individual crofters are not allowed to interfere with the sheep in any way. On one of the larger grazings herding is done by two paid shepherds, who are given assistance at tupping time, but on other grazings shepherds are employed only in the tupping season. The committee appoints gathering days and delegates crofters to assist at such operations as gathering, washing and dipping, but each crofter shears his own sheep and sells his own wool. Where shepherds are not employed and there is a lack of fencing, the difficulty of keeping the ewe lambs separate is overcome in the following way. The ewe lambs are housed at night and are hand fed with hay and turnips or potatoes, and occasionally "sheep and lamb food." During the day they are turned out of doors and have access to the common grazing, but they always return at night to their own croft. About the 1st of April the ewe hoggs are driven out to the remoter parts of the grazing and the ewes are taken down to the arable land for lambing. The ewes are mostly hand fed during the lambing period. In some districts ewe hoggs are wintered on the hill, but in one or two districts they are wintered on the croft, turnips being commonly given in addition to grass.

The percentage of lambs is usually somewhere between 80 and 90, varying considerably according to the season. On an average all the ewe lambs are required to keep up the normal ewe stock. As a rule ewes are not tupped until they are two and a half years old, three crops of lambs being taken. Most of the tups are obtained on loan from the Department of Agriculture for Scotland, the committee paying 25*s*. per tup. Usually they come off neighbouring farms and the results have generally been satisfactory.

When the lambs and cast ewes are ready for marketing, each crofter's sheep are examined and classified into various grades, but all the sheep are marketed together in their different grades, each crofter's account being credited according to the numbers of sheep he has in each grade. As in the case of cattle, the crofters are much handicapped by reason of the distance from a railway station and market, nearly a week being usually occupied in walking the sheep to the nearest station. A separate account is kept for each individual crofter, and at the end of the year he receives cash for any balance due to him. In one of the best districts the gross returns from sheep on an average croft would be somewhere about £27, while the expenses would be about £6, leaving a balance of about £21 to meet the cost of hand feeding in winter and at lambing time and to pay for the crofter's own labour, rent, and interest on capital. In the poorer districts, however, the average gross returns would probably not exceed £19 and the expenses would be about £5, thus leaving a balance of about £14.

There is no doubt that the wintering of the ewe lambs and the keeping of the ewes on the arable land at lambing time constitute a heavy burden on the resources of the croft. Generally speaking, it is not customary to spend much on draining or fencing. Drainage is often very much neglected, and on some grazings conditions are made worse by the fact that horses and cattle are allowed to run at large on the grazings and so tramp in the drains. In many cases additional fencing to divide the lower part of the grazing from the higher would effect economy in herding, would enable the higher parts to be better utilised, and by reducing the necessity for constant dogging would improve the condition of the stock. The reporters consider that the policy of doing without a shepherd is one of doubtful benefit. It has been adopted in some townships because of a desire to economise, especially as ample unpaid labour is available, but the results are not altogether satisfactory.

The quality of the sheep stock is generally fairly good, but the prices obtained are usually considerably lower than in the case of the neighbouring sheep farms. Losses are incurred through various causes, such as drowning in swamps or burns, or by the sheep being cut off by the sea when feeding on seaweed. Braxy is not common except in one district, where special precautions are taken in the way of wintering the sheep away from home or inoculating them. The inoculation treatment is, generally speaking, successful in preventing death, but the opinion was expressed by the crofters that the development of the sheep was arrested, so much so, indeed, that by the time the ewe hoggs were three years old and had their first lamb they did not give enough milk. The reporters found it difficult to gauge the reliability of this opinion, particularly in view of the comparatively recent adoption of this treatment, but some townships were so convinced of the harmful effect of the treatment that they had given it up. Liver fluke gives some trouble; any sheep affected are dosed with Danistol, while carbon tetrachloride capsules are also used as a precautionary measure. The only other disease that appears to cause appreciable loss is one known locally as "Yellows." This is apparently a dietetic disease associated with indigestion and liver disorder, and attacks lambs usually in the early part of the summer, the skin of the face and the ears being affected. Frequently the whole or part of the ear comes away, and although the sheep may recover, the loss of the ear, which is the principal means of identification in Cheviot stocks, makes it almost imperative to dispose of sheep so affected. Curiously enough, this disease is confined to certain grazings.

Pigs and Poultry.—Pigs are kept on only a few crofts and are killed for home consumption. There are no breeding sows in the district.

The number of fowls kept per croft varies from an average of about a dozen in the poorer districts to 20 in the better districts. Owing to the relative congestion of the crofts and to the fact that only a limited amount of home grown food is available and that purchased food is relatively dear, the keeping of large flocks is hardly practicable. At the same time the reporters consider that there is room for improvement in the management of the existing flocks.

Financial Results.—The reporters made an estimate of the income and expenditure of the average croft. The normal cash income from a croft consists of the net income from sheep and wool, the sum obtained from the sale of one or perhaps two young calves, and the amount received for eggs sold. In one of the best districts, where the soil is relatively fertile and where the management is particularly good, the reporters estimated that the average total income would amount to about £30. The average expenses, including rent, rates, tradesmen's accounts, feeding stuffs, manures, seeds, &c., were estimated to amount to about £12, leaving a balance of about £18. The average net income over the whole district would, however, be somewhat less than this amount, probably about £15. The profits from two sheep stock clubs, to which a number of the crofters belong, are not included in the above figures as all the profits made by these clubs are, in the meantime, used to pay off loans. In time, of course, the profits will be distributed amongst the shareholders.

The reporters point out, however, that only a very small proportion of the crofters (less than 5 per cent.) were able-bodied men depending on a single croft for their living. Many of them were engaged in fishing, which is, however, a rather precarious business, while others worked on the roads, acted as ghillies during the season, and undertook such work as hill drainage and road making in other districts. A fairly large proportion, probably more than a third, were old age pensioners, retired people and persons with private means or in receipt of assistance from relatives.

Deer Forests.—As already indicated, a large proportion of the area covered by the survey consists of deer forest. A comparatively small number of cattle and sheep is grazed on this land, and the reporters express the view that a considerably larger stock of both cattle and sheep could be permanently grazed without unduly interfering with the deer, although from the point of view of the necessity for the provision of subsidiary employment for the crofters the deer forests form a valuable asset to the district. A number of the permanent employees of the forests are in effect crofters, possessing a piece of arable land and owning their own cattle and sheep.

General Remarks.—The reporters make various general remarks and suggestions, the chief of which may be summarised as follows :—

(1) Generally speaking, the most is being made of the agricultural resources of the district, apart perhaps from the possibility of increasing the stock on the deer forest land. The chief drawback to any development of the agriculture of the district is the lack of transport facilities.

(2) The general management of the privately occupied sheep farms is very good, though fairly striking differences are revealed in comparing one farm with another. It is suggested that some of the ewe hoggs that are at present being wintered away could be wintered at home were more of the low ground kept for this purpose, and provided due precautions were taken by inoculation to prevent braxy. In some cases, too, more wintering could be provided if the grass land were top dressed with artificial manures.

(3) While the rules for the management of the common grazings appear to be very well drawn up and, generally speaking, loyally adhered to, the reporters suggest that continuity in policy and management would more readily be effected if in certain cases the committee members retired in rotation every third year instead of the entire committee being elected annually.

(4) On many common grazings too little attention is paid to such matters as drainage and herding. Individually every crofter is extremely interested in his sheep and spares no effort to look after them well while they are in his own hands, but when the sheep go on to the common grazing the individual crofter feels rather helpless, and there is not always sufficient leadership and co-operation to ensure that such matters as drainage, herding, &c., are effectively dealt with. This is particularly the case where there is a number of adjoining common grazings, where any action on the part of one committee might be of little avail without the co-operation of the other committees; for example, were one common grazing to be drained there might be the difficulty that horses and cattle from adjoining townships could not be prevented from straying on to that grazing and damaging the drains. A number of the smaller common grazings might with advantage be amalgamated.

(5) The prices obtained for wether lambs and cast ewes from the common grazings are considerably lower than the prices obtained in the case of the large individual farms. Various reasons are put forward to explain this.

Although the management is vested in a committee who are responsible, among other things, for the tups, the selection of the female breeding stock is in the hands of the individual crofter, who, as a matter of fact, has little choice seeing that all the ewe lambs are normally required to keep up the ewe stock. On the large farms the percentage of lambs reared is usually considerably higher, with the result that there is a fair proportion of surplus ewe lambs, and usually the worst are disposed of. Moreover, on the large farms great care is taken to select only the best tups for their own use, whereas the grazing committees have to be content with what rams they can hire, and these not infrequently are the second draw from these large farms. The wintering of the younger sheep and the lambing of the ewes are in the hands of the individual crofter, and do not seem to be carried out so well as on the large farms.

(6) Although it has hitherto been considered bad practice to put gimmers to the tup, the reporters suggest that it is perhaps worth considering whether there is a case for adopting this policy on the better grazings provided sufficient attention were paid to breeding and the gimmers were fairly well wintered.

(7) It would undoubtedly be beneficial if each croft could be ring fenced. The drains and ditches of the arable and grass land might in many cases be kept in better order, while the increased use of artificial manures would probably have the two-fold effect of enabling the crofters to dispense with some of the purchased foods and at the same time of permitting them to winter their stock better.

(8) In some districts an extension of the poultry side of the croft's activities might probably be undertaken, though there are certain disabilities, particularly the necessity for the purchase of more food stuffs and the difficulties of transport, which make the keeping of large flocks in general impracticable.

(9) Although parts of the district surveyed might be considered fairly prosperous compared with most other crofting districts, and although a very great part of the agricultural resources are exploited by the crofting community, the general trend of affairs is towards depopulation and dissatisfaction with crofting conditions. This is clearly evidenced by the decline in the school population. In the poorer townships the crofts are mostly occupied by old people and there is a tendency to sublet or merge crofts. Few of the young people feel inclined to stay at home, and a considerable proportion migrate to the large towns or to the colonies. Under modern conditions it would appear to be the case that a croft such as is found in the district surveyed, while enabling a family to live cheaply, cannot by itself provide a livelihood; in such a district subsidiary employment must be found, and the chief problem at the present day is how to obtain sufficient subsidiary employment.

(2) PARISH IN ARGYLLSHIRE.

This parish extends to between 25,000 and 30,000 acres, of which 22,000 acres are used for agricultural purposes, the remainder being occupied by woods and scrub, inland water, buildings, &c. Of the agricultural land, 93 per cent. (or approximately 20,000 acres) consists of mountain and heath land used for grazing, 4 per cent. (or about 900 acres) of permanent grassland, and only 3 per cent. (or about 700 acres) of arable land. Most of the land is below the 1,000 feet level. On the mountain slopes the soil is thin, stony, and heavily leached, containing various proportions of peat. Pure peats are not extensively developed, and on the grass-heath land there is little peat. The typical soil of the flatter lowland is a loam, but mossy soils occur in the wetter areas, while sands and gravel lie distributed along the coast. The average annual rainfall is fairly heavy, ranging from 45 to 60 inches. The topography of the land and the distance from markets render imperative the adoption of some form of stock rearing as the basis of the agriculture of the parish. On the mountainous land sheep rearing is the chief industry, cattle being of secondary importance; but in the less mountainous regions the proportion of cattle increases. Crops are grown mainly for stock food.

Holdings.—There are 66 holdings in the parish. One consists entirely of mountain and heath land, while the other 65 are classified according to the extent of arable and permanent grassland acreage as follows :—

Acreage:	*1–5 acres.*	*5–15 acres.*	*15–30 acres.*	*30–50 acres.*	*50–75 acres.*	*Total.*
No. of Holdings	8	17	20	14	6	65

Practically every holding has a stretch of mountain and heath land ranging from a few acres to over 2,000 acres. In the majority of cases the arable acreage is very small compared with the extent of grazing land. The reporters divide the holdings into three main groups, viz. :—

A. (26 holdings).—Sheep farms on which regular sheep stocks are carried, some cattle also being reared in most cases.

B. (26 holdings).—Cattle-rearing farms on which there are no regular sheep stocks, but on which hoggs are wintered.

C. (14 holdings).—Small crofts, the occupiers of which do not subsist entirely on the resources of their crofts, but eke out their livelihood in various ways, e.g. rabbit-trapping, fishing, estate employment, road mending, &c.

With regard to group C, the stock generally consists of a cow and a follower or occasionally of two cows with followers, the only cash income normally obtained as a result of the tenancy of the land coming from the sale of a stirk. A few hens and pigs are kept, and usually a small acreage of potatoes is grown for home use. The rent of the holdings varies from £2 to £18 per annum. The holdings are important mainly in that they provide a cheap means of livelihood and facilitate certain trades in the district. For instance, without a holding it would be impossible for a blacksmith to subsist on the proceeds of his calling.

The remarks which follow refer, therefore, to the holdings in groups A and B.

Crops.—The rotation most generally followed is :—oats, roots, oats, ryegrass hay, ryegrass hay. It is fairly common, however, to allow the grass to lie for three or even four years. Leases on some of the estates require that an outgoing tenant must leave the land under a six-course rotation.

Oats.—This is the only grain crop grown, the most popular varieties being Sandy and Potato. The average yield is estimated at 35 bushels per acre.

Roots.—Farmyard manure and generally also small quantities of compound artificial manures are applied to the root crops. The acreage of turnips grown is small, being only about 1¼ acres on an average. The average yield is estimated at between 15 and 18 tons per acre. At one time, about thirty-five years ago, potatoes were exported to England and to Ireland, but now they are grown almost entirely for home consumption. Kerr's Pink is the favourite variety, but Abundance, Arran Victory, Arran Chief, Great Scot and Epicure are also grown. The average yield is estimated at between 6 and 8 tons per acre.

Grass.—Many of the farmers get their grass seeds ready mixed from the merchants and do not know what grasses and clovers are included. Those who mix their own seeds confine themselves mainly to ryegrass, alsike and red clover, the ryegrass being sown at the rate of two bushels per acre. Wild white clover is included in comparatively few of the mixtures and the reporters consider that a wider use of it would be profitable. Farmyard manure is applied to the hay, and on the larger farms small quantities of potash salts or superphosphates are also applied. The yield of ryegrass hay varies considerably, but the average would seem to be about 35 cwt. per acre. The acreage of timothy meadow is negligible. The only treatment given to the permanent grass seems to be the application of small quantities of slag on some of the larger farms.

Rough Grazings.—The grazing land of the parish appears to be gradually deteriorating. Over a period of forty years the numbers of cattle and sheep have decreased by more than 30 per cent. Various explanations were offered by the farmers in the district for this decline, for example, the decrease in the arable acreage, the increase in moss, bracken and scrub, the lack of lime, &c. While there are no doubt various contributory causes, the reporters express the view that probably the main cause of deterioration of the grazings is the loss of minerals due to continual depletion by cattle and sheep for generations, and in this connection they refer to the importance of the work which is being carried out by the Rowett Research Institute. Not only may the suggested mineral deficiency have an important bearing on the stock-carrying capacity of the grazings, but it is probably significant that the incidence of diseases of sheep in the parish is very heavy.

Stock.—*Cattle.*—While the breeding and rearing of cattle for sale as stores is the principal object on group B holdings, this department also occupies an important place, though subsidiary to sheep, on group A holdings. Butter is frequently sold from the holdings in the former group. The average number of cows kept per holding over the two groups is eight. The majority of the cows are cross-bred, principally from Ayrshire cows by Shorthorn bulls, though there is a number of pure Ayrshire and also Highland herds. Aberdeen Angus, Shorthorn and Highland bulls are used. Some of the calves are pail-fed and some suckled, but pail-feeding predominates. Where suckling is the method the calves are normally with the cows at feeding time only. Most of the young cattle are wintered inside, though the stronger animals may be wintered out on the low ground. Those wintered indoors receive hay, unthreshed oats, bean meal and cake, and, if available, a few turnips; those wintered out receive hay to supplement the grazing. None of the cattle are grazed, even in summer, on the higher rough land. Cattle are usually kept until they are at least two years old, but financial stress has of late years compelled many farmers to dispose of animals earlier, either as six-quarter olds or as stirks. There is no outstanding disease amongst the cattle.

The reporters consider that there is room for much improvement in the standard of cattle management in the parish. A number of the farmers lack knowledge of the first principles of breeding, and education in feeding methods is also required. Advantage could be taken more widely of the premium bull scheme of the Department of Agriculture for Scotland.

Sheep.—The sheep stocks on group A holdings are almost entirely Blackface, and with a few exceptions the reporters express themselves as not impressed with the quality of the stocks inspected. Nineteen of the stocks are bound to the ground, two at valuation prices, eleven at fixed prices and six at market value. Some of the farmers were definitely of opinion that the fixed price system does not encourage tenants to improve their stocks; that indeed it has frequently an adverse effect, as there is a temptation towards the end of a lease to sell off the best animals. In general, poor prices are paid for tups. On many farms the ewes run over the entire hill during winter, but where there is much high ground they are generally brought down to the lower ground during cold spells. It is very exceptional to feed ewes during winter, but tups are all fed, mainly on bruised oats and hay. On many farms the ewes are brought down to the lower parts of the grazings for lambing, but on others they are not moved. The percentage of lambs born varies from 60 per cent. to 90 per cent., the average being about 75 per cent. Wether lambs are sold at the August sales, but on most farms a few wethers are retained and sold ultimately as two and three year olds. Owing to the heavy death-rate the ewe lambs are mostly required to maintain the stocks. Four to five crops of lambs are generally taken. All sheep are dipped in August and October or November, but one or two additional " fly " dippings are given in summer by the majority of farmers. Hoggs are normally wintered at home, but from a number of farms they are sent away, some to neighbouring holdings and others to a considerable distance. The death-rate amongst hoggs wintered at home and in the neighbourhood is generally very much higher than amongst those wintered out of the district. The wool clips vary from 4½ lb. to 5½ lb. for ewe hoggs and eild ewes and from 3½ lb. to 4½ lb. for milk ewes.

The management of sheep on the B group of holdings is extremely simple; ewe hoggs, mainly from the group A holdings, are taken in for winter grazing from 1st October to 1st April. The prices obtained range from 8*s*. to 9*s*. per hogg, though higher prices are obtained for sheep from certain neighbouring islands.

The position with regard to disease in sheep is a serious one. The general death-rate varies from 6 per cent. to 50 per cent., the average being not less than 15 per cent., and according to the information given to the reporters the rate appears to be increasing. Fluke is estimated to account for about 50 per cent. of the total deaths. Treatment is neither general nor well-instructed. A number of farmers use carbon tetrachloride or Danistol, but the majority of these dose only sick animals, and it is not commonly appreciated that all animals, and not only those affected, should be treated. Braxy is the principal disease of the younger animals; very few farmers, however, inoculate their sheep. Maggot fly seems to be very bad, but the farmers appear to be doing what they can to mitigate the pest. The prevalence of bracken makes the task more difficult, as affected sheep seek shelter in the growth and are not easily detected. Louping-ill also occurs sporadically throughout the parish. The reporters state that they formed the opinion that while the serious nature of the position is well recognised by the farmers a large number of them are either unreceptive of new ideas or uninstructed in modern methods. The reporters consider that agricultural education might be so organised as to render more assistance than is given at present, and suggest that much good would result if veterinary experts were available to give advice.

Pigs and Poultry.—On some farms a few pigs are kept, but they are not regarded as of great importance.

On practically all holdings a number of poultry is kept and some eggs are sold locally. The reporters consider that this branch could probably be more highly developed, particularly on the group B holdings.

Labour.—About half of the farms in both A and B groups are worked by the occupier and family without the assistance of hired labour. On the majority of the other farms the hired labour consists of a shepherd or a handyman or, in quite a number of cases, of a boy or youth, frequently sent from Glasgow and other urban areas by the local authorities. These boys are primarily engaged for the herding of cattle in summer and hoggs in winter, the lack of fences making this necessary.

Drainage.—While a certain amount of hill drainage has been carried out, mainly on the larger sheep farms and with the aid of Government grants, much more still remains to be done. Extensive stretches of hill land were found to be in a very wet condition, which must adversely affect the health of the stock. On the smaller hill farms the conditions are described by the reporters as deplorable. Much of the arable land also requires drainage improvement, but this is not a matter of such outstanding importance as the surface drainage of the grazings. The reporters express the opinion that the Government scheme is having a good effect on the larger farms, but the occupiers of the smaller farms are apparently too poor to take advantage of the scheme; they cannot find the cash to pay the requisite two-thirds of the cost.

Liming.—From the results of the tests made with "Soiltex" and an examination of the flora the reporters express the view that the application of lime to the arable and the pasture land would probably effect considerable improvement. They consider that experimental and demonstration work might usefully be carried out. There is evidence of a fair amount of limestone in the parish, and the reporters suggest that co-operative action, with the help possibly of the State, might be taken by the farmers for the purchase and erection of grinding machinery.

Bracken, Heather and Scrub.—The control of bracken is one of the most serious problems in the parish. The reporters estimate that 10 per cent. of the rough grazings is covered with the plant. Not only does it do damage by occupying much of the best grazing land during the summer, but it may be harmful in other ways, as, for instance, by concealing sheep affected with maggots. It is possibly, also, an indirect cause of an increase in fluke disease as it occupies the higher and drier land, and sheep are therefore inclined to seek food on the lower and wetter areas. A clause in some of the leases binds the tenants to cut one-third of the bracken area annually. On a few farms men are hired for the purpose at an annual cost of as much as £30. The general impression formed by the reporters was that on many farms bracken is increasing; on many others, though it is held in check, it constitutes a serious problem, and only on a few is it being suppressed.

On the whole heather burning is fairly well carried out, notwithstanding the fact that the weather conditions are frequently unfavourable. On a number of farms, however, more burning could undoubtedly be done. A condition of many leases is that the tenant shall not burn heather without the written consent of the proprietor. The actual burning is usually done by the keepers, assisted by farm labour.

Numerous complaints were received by the reporters in regard to the spread of scrub, mainly birch, over the rough grazings. Not only is it usurping much of the lower grazing lands, but it makes the herding of sheep difficult and the extermination of rabbits impossible. No objection is apparently taken by the proprietor of the estate on which it is most prevalent to the farmers cutting the scrub, but the farmers maintain that the scrub is too extensive for them to keep it in check without assistance. It may be mentioned that according to the last census of woodlands the acreage of scrub in Argyllshire is given as over 50,000 acres.

Rabbits and Game.—Rabbits are a very serious pest in the parish. Many farmers let the trapping by contract, while others attempt to keep the pest in check themselves. The receipts from this source often form an important part of the farm income, the annual profits varying from £5 to £80 on individual farms. Each farmer maintained that he would prefer to have his land clear of rabbits and have no income from this source, and so avoid the loss due to damage to crops and pasture. Some complained that it is impossible to get their farms cleared because fresh stock comes in immediately from neighbouring land, and it was asserted that, as it was not in the contractor's interest to kill out the rabbits entirely, a nucleus of breeding stock is deliberately left by them on some farms. Scrub, bracken and rocks combine to make trapping and shooting difficult. The attack on the pest is usually made in winter when prices are good. The reporters consider that extermination of the rabbits can be effected only by concerted action, in summer as well as in winter.

On a number of farms damage is done to crops by pheasants, and it was stated in some cases that for this reason oats and turnips are not being grown, with the result that additional expenditure is being incurred on the purchase of feeding stuffs. There appears to be a reluctance on the part of the tenants to take advantage of their rights to compensation for such damage under the Agricultural Holdings (Scotland) Act, 1923. Deer are occasionally seen but they do not cause much damage in the district.

Buildings, Fencing and Equipment.—While the majority of the steadings are fairly satisfactory, in quite a number of cases the byres are very poor. Owing to the low roofs some are almost without light and ventilation except for the door, while the accommodation is inadequate in some cases. The majority of the farm houses are quite good, though modern conveniences are not infrequently lacking. A number of houses, however, is classed as bad, the principal defect being dampness. The workers' cottages, though few in number, are fairly good.

Many of the group B farms suffer from an entire absence of march fences, the interior fences being often temporary erections by the tenant. It is therefore impossible for the farms to carry regular sheep stocks. The existing fences and dykes are in moderately good repair. The sheep fanks and dipping tanks are only of a fair standard. The farms are generally equipped with the usual implements, though in some districts there is a scarcity of threshing mills, with the result that oats are in some cases fed unthreshed.

Marketing and Co-operation.—One of the chief difficulties under which agriculture is carried on in the parish is the lack of cheap and suitable means of transport, though there has been a definite improvement in this matter since the reorganisation of the West Highland shipping services took place. The reporters consider that much of the difficulty with regard to transport could be overcome by better co-operation amongst the farmers.

A certain amount of co-operation is at present taking place; for instance, in the joint use of bulls, small threshing machines and reapers, and to some extent in the co-operative sale of wool. The reporters are strongly of opinion that co-operative enterprise could be stimulated in the district, and suggest the following directions in which this might be done.

1. Co-operative selling of produce. Special boats might possibly be chartered. It is suggested that apart from other advantages this would enable potatoes to be marketed profitably in normal years. Co-operative marketing would also stimulate poultry keeping, a branch of farm economy which is poorly developed at present;
2. Co-operative buying of agricultural requirements;
3. Co-operative action in regard to the use of lime;
4. An extension of the use of good stud animals;
5. An increase in the number of jointly-owned threshing mills.

A central store would, of course, be a necessity for the purposes of co-operation.

Financial Results.—In most instances the farmers in group A, even where the holdings were being entirely worked by the family, seemed to be making a livelihood only with difficulty. With regard to the holdings in group B, the reporters found that the occupiers were managing to make ends meet where the family did all the work, or where only a boy was employed at a low wage mainly for herding stock. Where, however, expenditure had necessarily to be incurred on the employment of skilled labour in consequence, for example, of the occupier being incapacitated by age or illness, a loss was certainly being incurred.

General Observations.—The general conclusions and suggestions of the reporters are as follows:—

1. There is room for considerable improvement in the standard of agricultural practice in the parish.

2. The quality of the majority of sheep and cattle stocks is poor.

3. Sheep diseases cause immense losses, and it is suggested that an improvement could be effected if the services of specialist veterinary advisory officers were available to farmers in areas similar to the district surveyed.

4. Bracken and scrub are giving great trouble, and an extensive campaign directed towards eradication is necessary.

5. Much of the land appears to be in need of lime, and it is suggested that the possibilities of using ground limestone and the erection of grinding machinery should be investigated.

6. A great part of both the hill and arable land, particularly the former, is in need of drainage, but many of the holders stated that they could not afford to take advantage of the Government's Drainage Scheme.

7. Rabbits are a serious menace and do great damage to the

grazing lands and crops. Concerted action is necessary if they are to be reduced to negligible numbers. Pheasants also cause a certain amount of damage.

8. Many farm roads require extensive repairs. In some cases byres are of a poor standard, and there is a lack of fences in some areas.

9. Transport and marketing costs are relatively very high, and it is suggested that co-operation would do much to effect economies.

10. Except in the case of the occupiers of the larger sheep farms, the farmers in the parish are doing little more than earning a bare living. The systems of agriculture followed on both group A and group B holdings seem to be suited to the district, and under existing economic circumstances no alternative system seems to offer any better prospect. It is possible, however, that an increase in the arable acreage in some cases would be economic.

(NOTE.—*This is the concluding article of the series of summaries of reports of the agricultural surveys which have been carried out. In the next issue of the* JOURNAL *it is proposed to review briefly some of the questions brought into prominence as a result of the surveys.*)

THE BIOLOGIST on the FARM.—No. XLI.

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Fair Play for Wood-Pigeons.—We used to teach that the wood pigeon was on the short black list of birds for which few good words could be said *from the farmer's point of view;* and we still believe that it is in the interests of agriculture to put a severe check on the multiplication of this handsome bird. We have heard of just over a thousand oat-seeds in one crop; and Dr. Collinge's account of the crop contents of 428 birds taken throughout the year is very convincing. He found that 96·5 per cent. of the food was vegetable, and of this vegetable food 38·5 per cent. was grain.

But just as there is something to be said for poisonous snakes, which help to preserve the Balance of Nature by destroying small rodents, so it has to be recognised that wood-pigeons sometimes devour and digest the seeds of weeds, like charlock and ragwort, besides doing away with many an injurious caterpillar and slug. It is grotesquely anthropocentric to estimate every creature by its plus or minus relations to man's interests, but it would be ecologically surprising if even the wood-pigeon was altogether detrimental to farming. All vital issues are complex, and all wholesale statements are to be distrusted. Thus we are interested in a recent study of wood-pigeons' crops by Dr. W. Maldwyn Davies of Bangor. He investigated fourteen crops of birds shot in February, when there is little chance of getting food of agricultural value, and he found that the main diet consisted of Ivy Berries and Buttercup leaves. In several cases there were over a thousand Ranunculus leaves in a single crop. Other plants, such as clover, sorrel, and grass, formed a small portion of the food. For that month, then, in that area, it might be said that the wood-pigeon was rather " beneficial " than otherwise. The moral is that verdicts should always be based on the crop-contents of many birds taken throughout the year. We hope that we will not be accused of pleading for wood-pigeons, for we have no use for " Heaven and Hell Amalgamation Societies." The bird, in many ways attractive, must be kept severely in check, but " the devil is not always as black as he is painted." Give the wood-pigeon its due.

Seed Scattering.—This is the wrong time of year for studying the dispersal of seeds, and yet perhaps it isn't, for it is still easy to see young plants appearing in uncrowded places—to put it mildly—and in many cases we cannot but wonder how they came to be there. Not far from where we write there is, in a notable wild corner, a colony of Birth-wort (*Aristolochia Europœus*) that we may describe some other time. It is not a British plant, and we do not suppose that there are at present many, if any, other instances of its occurrence on our shores. It is wild in some parts of France, and the seeds may have been carried across by birds; or it may be an " escape " from some garden; or some one may have planted it in its wild retreat to tease the botanists, just as we know a joyous enthusiast who has as one of his ploys to take a stone from the top of Ben Nevis and deposit it as a votive offering on the summit of Snowdon, and *vice versa*. Some people can't leave Nature alone!

There has recently been published a big book—a Three Guinea book alas—on the scattering of seeds and spores (*The Dispersal of Plants throughout the World*), by Mr. Henry N. Ridley; and it is an interesting story well told. It demonstrates the striking commonplace that plants though fixed in the ground have been as successful travellers as animals that can usually move about of themselves.

There are only a few great methods of scattering—(*a*) by the wind, as to great altitudes on the mountains, to the tops of trees in the tropical forest (where many perched plants flourish), and to distant islets of the sea; (*b*) by water,—as by streams, floods, ocean currents, and even ice; (*c*) by birds and mammals, fishes and insects, and some other animals, to which seeds become attached, or by which seeds are swallowed, and afterwards voided without being digested; and (*d*) by some unusual exertion on the plant's part, as when the fruits of the sand-box tree (***Hura crepitans***), well known before the days of blotting paper, explodes with a loud noise and jerks out the seeds, just as our whin-pods and broom-pods do on a smaller scale. There is a kind of mistletoe in California that squirts the seed out with so much force that it may traverse two or three yards, sometimes striking a branch and thus attaining by a method of its own what other mistletoes effect when the pulp of the berry is half-eaten by the missel-thrush or some other bird, and the sticky seed wiped off on to a branch. The flowers of the Toad-Flax, *Linaria cymballaria*, which beautify old walls, turn to the sun when they are young, but as they grow older they hide their heads in dark crevices, where the seeds ripen. Thus we understand how a young toad-flax plant appears out of a crevice in a wall.

There are of course scores of ways in which a seed, or it may be a fruit, is specially adapted for dispersal. As everyone knows, it may have silken parachutes, or it may have buoyant floats, or it may be so rough that it adheres to the passing mammal's fur, and so on and so forth. But it is of great evolutionary interest to notice the conclusion of Mr. Ridley's comprehensive survey that there is no *sudden* appearance of a novel structure that secures scattering, meaning by sudden that it is unconnected by gradations with antecedent structures put to some other use. "The evolution of a winged or adhesive fruit or seed seems to have been gradual, and to have been effected by a reduction or accrescence of certain parts, which had a primary use not connected with dispersal." Thus a silken parachute may be due to an exaggeration of hairs that served first of all to keep the seed-box from getting wet. This is one of the methods of evolution—new structures from old; and it is plain enough that they would help the dispersal a little for many a generation before they became strong enough to help a great deal. We can see this in the farm, and it is worth wrinkling our brows over.

Red Water.—A correspondent has kindly sent us a spray of water-weed dotted with a few pink-red spots. We put it in a tube on our work-table, and in a few days it has spread over many leaves so that a considerable part of the spray is beginning to show a somewhat striking and not unpleasing red colour. It looks as if the green plant was becoming red, though what is really happening is that a reddish organism is multiplying rapidly and spreading over the leaves.

Microscopic examination shows that the red spots are clusters of single cells with a reddish pigment, and a few of these are swimming about singly in the water. They belong to a genus called Sphærella or Hæmatococcus, often ranked among the Infusorians, and regarded as related to the common green Euglena, which is often so abundant in ditches and puddles that the whole water is coloured. At the base of the locomotor lash of Euglena there is a cluster of reddish granules forming an "eye-spot," though hardly worthy of that title; and it is this reddish pigment, hæmatochrome, which is exaggerated in Sphærella and masks the green pigment or chlorophyll. Sometimes there is more of the red and sometimes there is more of the green; and it looks as if there was some sort of physiological see-saw between them. The red pigment, hæmatochrome, does not seem to have been much studied, but it is usually referred to the series of lipochromes or fatty pigments, a group which includes the carotin of carrots and the zoonerythrin of shrimps! It occurs in a number of single-celled organisms, and it is almost a matter of opinion whether these should be ranked among plants, as Algæ, or among animals, as Infusorians. When they are very abundant they may give the water a reddish colour, and in the glass vessel before us the Sphærella is, as it were, painting the plants red. In byegone days this reddening of water sometimes received a superstitious interpretation.

Red Rain.—Showers of red rain have been often recorded, but seldom studied with precision. They are due to the upsweeping and updrawing of countless millions of reddish microorganisms of various kinds, which become associated with the films of rain-drops, and, after being wind-borne, eventually sink to earth, perhaps hundreds of miles from their origin. In most cases they come from shallow water basins, but they may become associated with dry dust. In cases recently investigated in S.E. Australia, the redness was due to species of diatoms—unicellular plants with a siliceous encasement—belonging to the genera Nitzschia and Cocconeis. The pigmentation of diatoms is due partly to chlorophyll and partly to a golden-yellowish colouring matter called diatomin. The Diatoms that have formed the bulk of the red rain of Victoria in a succession of recent years had still some hints of life in them when they fell, for the rain was sticky, and big drops persisted for days on the leaves of plants. Diatoms are found abundantly in fresh water, in certain damp soils, and in the sea; those that fell in Victoria seem to have been borne by the wind from arid regions to the north-west and in Central Australia. The most striking feature was the quantity, for one night's shower is said to have brought down 51¾ tons per square mile at Balwyn, near Melbourne, and 24 tons per square mile at Elsternwick. On another occasion Mr. Frederick Chapman, one of the investigators, had a shower in his garden, which indicated a fall of 64 tons to the square mile! So red rain may come to have agricultural importance.

Finger-Prints.—One of the great books of recent months—the outcome of many years—is Professor Karl Pearson's Life of Francis Galton. The first two volumes appeared some ten years ago, and now we have the third and final volume, which had to be divided into two because of its size! There is reason to congratulate the distinguished biographer on the success of his achievement, for the Life (which includes many letters) is so perfect that no one need ever return to the subject, unless to write a popular appreciation of Galton's work. For as the price of the concluding volumes is six guineas (we have forgotten what the first and second cost), there is considerable need for some book more accessible, such as Professor Pearson's son could readily write, after the fashion of his interesting sketch of Erasmus Darwin.

Many pages of this great work are devoted to Galton's studies on finger-prints, which afford the best known biological illustration of individuality. Each one of us has a particular pattern of ridges, loops and whorls on the under surface of our finger tips; the pattern remains practically the same throughout life; and no one else has our particular pattern, unless perhaps our identical twin brother, but not always he! As everyone knows, the individuality of the pattern is so trustworthy that a criminal may be discovered and convicted on the strength of his previously registered finger-prints. But for the biologist the interest is theoretical, that in these details there is an expression—a scientifically describable expression—of individuality. The pattern of the ridges, loops and whorls is an indication of that mysterious something that makes each man himself and no other. A bird species may be identified from a single feather, and a fish species from a few scales, that is *specificity*; but here we are dealing with the sign-manuals of the individual, with *individuality*.

What are these ridges, that we often see glistening with droplets of sweat on a hot day,—for the delicate openings of the glands are on their crests? They are coalesced rows of epidermal papillæ—like closely adjacent mountain-peaks united in a curved ridge. And if a hypothetical ultra-delicate needle could be inserted perpendicularly through one of the epidermal papillæ (coalesced in ridges), it would pass through the epidermis into the under-skin or dermis *between* two of the dermal papillæ. That is to say the innermost part of an epidermic papilla has a dermic papilla on each side of it, so that there is a kind of interlocking, which may possibly have some physiological value in increasing the mechanical firmness of the skin and its intricate cellular fibrils, or its nourishment from the capillaries, which do not pass beyond the dermis, or even the thoroughness of the innervation. This seems to be an obscure question, but surely many books have made an unnecessary mistake in saying that the epidermal papillæ correspond to the dermal papillæ, whereas they really alternate with them. Does not the crest of an epidermic ridge correspond to the valley between two dermic ridges?

With a lens, or even with the naked eye, one can see that the apertures or pores of the sweat-glands are on the crests of the ridges, as was noticed by Nehemiah Grew, one of the pioneer microscopists, as far back as 1684. Herbert Spencer had not observed this, however, and in talking to Galton and cudgelling his brains to find some meaning in the ridges and valleys, he suggested that their significance was that the ridges protected the delicate sweat-duct openings which lay in the valleys. When Galton genially remarked that, unfortunately for the theory, the openings were on the *crests* of the ridges, Spencer "laughed uproariously." He then told Galton of Huxley's definition of a Spencerian tragedy—"a beautiful theory destroyed by an ugly little fact." And there's a moral here for most of us!

In any case when we next look at the imprint of a child's buttery fingers on the margin of a fair page, or our own sign-manual on a flagon, or the ridges on our thumb glistening with droplets of sweat, let us realise that here is a problem to chew at—the problem of individuality. The use of the ridges and valleys on the naked parts of the skin is doubtful; the conditions of development and growth that induce them are quite obscure; they have a pre-human origin, for simpler patterns are seen in apes and monkeys; but why are yours yours and mine mine. That's the rub.

More Bananas.—One of the features of our times, which is going to be a more and more prominent feature, is the use of science to overcome practical difficulties. It looks as if we were actually becoming tired of "muddling through," as if we were forming the life-saving habit of using the scientific torch to illumine *all sorts* of hindrances. The habit has been in some degree established in the domain of things, where we seek the advice of chemistry and physics and allied sciences when we get into difficulties, but it is still no more than incipient in regard to the realm of organisms. It is, of course, true that we use the light of biological science in regard to diseases, poor soil, Mendelian inheritance, and so forth; but the habit of appealing to Biology all along the line is still a-forming. Its growth will be encouraged by that fine book *The Science of Life*, by H. G. Wells, Julian Huxley, and G. P. Wells, in which "Biology for Life" is a dominant note.

We were led to this line of thought by a recent report on the transport of bananas by Messrs. Wardlaw and M'Guire. It is only necessary to look at the shops to see that bananas form one of the great crops of the world, and it is well known that they form one of the staple foods of mankind. Thus the health of bananas is of great importance, and one is sorry to hear that things have not been quite satisfactory of late. The so-called "Panama disease" has spread from South America, where it has run riot, to the West Indies, where it has become a menace. One of the modern methods in such a case is to try to find some variety that is relatively immune to the threatening disease; and there are some resistant races of banana. But some of these are not well suited for transport, and the problem rises of enabling them to stand the voyage without going wrong. Thus it is recommended that the big bunches of, say, the Cavendish variety should be pre-cooled before being cut up for packing in crates. Much seems also to depend on the careful handling of the fruits, well-protected as they are by their skins; and it was in this connection that we came across a little detail which sharpens our point, by illustrating the nicety of well-informed modern methods. When the banana stalks have to be cut before transport, there is the obvious risk of disease micro-organisms finding entrance by the exposed surface. It is therefore recommended that the stalks be cut with a sterilised knife and that the cut surfaces be smeared with vaseline!

Trapping Tse-Tse Flies.—Another of the crowding instances of man's conquest of difficulties is the recent success in trapping tse-tse flies, which are the carriers of Sleeping Sickness germs in man and of n'gana disease in stock. Unremitting endeavours have been in progress for years, but with little result in proportion to the energy expended. Attempts have been made to clear off vegetation from large belts so as to form barriers which the fortunately rather stay-at-home insects cannot cross, and in which they cannot breed. But this method is costly on a big scale. To another method, that of exterminating antelopes and other wild animals, supposed rather than proved to be the natural hosts of the Sleeping Sickness organisms (Trypanosomes), there are several sound objections. The latest suggestion, that of large scale trapping, has come from Mr. R. H. T. P. Harris, an entomologist working in Natal. The trap is a framework made of strips of wood and covered with dark hessian cloth. It is like the boards of a leafless book, hung with the binding down, and with cloth forming a flat top (6 feet by 3 feet) from board to board. The " boards " converge to about three inches apart and there is a narrow slit along the " binding," which is hung about 18 inches off the ground. The trap is thus somewhat triangular in cross section and the two vertical ends are closed with light cloth. To the flat upper surface there is then fastened a transparent cage of wire gauze so arranged that when the cloth is removed beneath, it rests on wires and opens into the hollow body of the trap by a non-returnable entrance. The whole trap is hung on the sunny edges of evergreen bush, each throwing a separate shadow. From a hundred to two hundred tse-tse flies may be caught in one trap in one day, and it is not even necessary to kill them since they soon die of hunger and exposure.

The whole point of these details from our present point of view is that the trap is a *scientific* one, that is to say, it is based on an understanding of the habits of the tse-tse fly. Why do the insects enter the trap at all? The answer is that they hunt by sight, and search about in strong sunshine for game animals whose colour-tone is in contrast to the surroundings. It is unlikely that they perceive shapes as we do, but they are attracted to "tonal contrasts"; and the trap with its shadow appeals to them as if it were an antelope! Darkish cloth was proved by experiment to be a distinct advantage. When the flies alight on an animal they seek out the under parts, perhaps to get out of the way of tail or muzzle, and perhaps because the under skin is softer for puncturing. Thus they explore the entrance to the trap, which is a foot or so off the ground. When they get into the interior and find nothing, they obey a light-seeking impulse or tropism and fly upwards to where the light comes in through the wire gauze. Then they are fatally trapped.

As a correspondent to the *Times* remarks, the adult seems to be the weakest link in the chain of the Tse-tse's life-history, and the trapping, which is cheap and requires little attention, takes advantage of the fact that the adults do not travel far and are attracted to dark objects. Providentially, so to speak, they are slow to multiply and non-gregarious.

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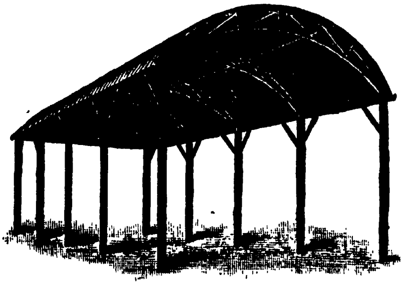

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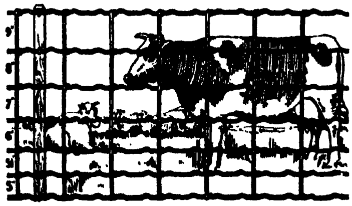

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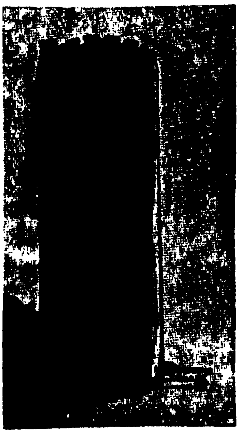

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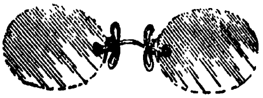

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A DISEASE-RESISTING TURNIP.

W. M. FINDLAY, N.D.A.,

North of Scotland College of Agriculture.

IN dealing with plant diseases the two general methods adopted are (1) the creation of soil conditions unfavourable to the attack or spread of the disease, viz. by drainage, by proper methods of cultivation, by the application of manures, &c., and (2) the production of varieties capable of resisting the particular disease.

These methods have been followed in carrying out trials at Craibstone on turnips grown on plots where this crop has been grown continuously for 16 years. The land has been badly affected with finger-and-toe disease from the beginning. Trials on the effect of applying lime as a preventive of the disease have been conducted over a period of years, and the results have been described by Professor Hendrick in the *Transactions of the Highland and Agricultural Society of Scotland*, 1923.

In addition, many varieties of both turnips and swedes, including all those that were claimed to be disease resisters, have been tested on these plots, but until a few years ago, although a number of varieties were undoubtedly better than others, none was found that could be said to be at all resistant under the very severe conditions of mass infection in these trials.

In 1925 the County Organiser for West Aberdeenshire noticed in the Skene district a purple top yellow turnip which was growing healthy crops on land where other varieties were badly affected with finger-and-toe. Seed was procured from Mr. John Milne, Upper Affloch, and sown on the affected plot, where it grew well and resisted finger-and-toe to a marked degree.

Inquiries as to the history of the turnip show that it has been grown in several districts of Aberdeenshire for nearly 100 years, chiefly by the smaller class of farmers and on land where it was difficult to grow healthy crops owing to finger-and-toe. In a good many cases where it has been grown successfully the soil is of a peaty nature. It is a common practice in the north-east of Scotland for farmers to grow their own turnip seed, and this particular seed is all home-grown. One farmer would give a pinch of seed to a neighbour or to a friend in another neighbourhood, and in this way, without any advertisement, it has spread gradually over a considerable area until it is estimated that there are now several thousand acres sown annually with this turnip.

The fact that it has been grown so long without its valuable characteristic being made public is so surprising that it has been thought worth while to place on record what is known of its history.

The turnip is known in different districts by several different names, generally referring to some individual who was prominent in introducing and spreading it. In Skene and district it may be called the Skene Purple Top or the Uncankerable; in the Cruden and surrounding district it is called Geordie Henry; in the Pitsligo, Strichen and Fraserburgh districts Tammie Mackie; in the Bulwark (between Auchnagatt and Maud) district it is called either Sandy Robb or the Bulwark Champion; in the Muchalls district the Newhall Neep; in some districts of Banffshire it is known as the Canker Resister, while in Deskford it is known as Russell's Neep. It is also known is some districts as the Red Neep or the Black Neep.

All the available information indicates either that it originated at Inverquhomery, Longside, nearly 100 years ago or that it was introduced there from a source which cannot now be traced. Inverquhomery was then owned by Mr. James Bruce, who had been a successful shipowner in Peterhead and had purchased the estate in 1827. He died in 1862 and the estate passed to his nephew, also named James Bruce, who had been a sheep farmer in Australia, and who was well known as a keen agriculturist and as a grower of turnips for seed; indeed, a swede of the north country type is called Inverquhomery.

Many of the farmers who are now growing the Purple Top for seed on a large scale have agreed to name it "The Bruce." It is hoped that this will now be adopted as the universal name and that there will be no synonyms as in the case of many other crops. Of course, if anyone makes a superior selection he would be entitled to give it a distinctive name, and it is suggested that he call it his selection of the Bruce, thus—William Wallace's selection of the "Bruce."

A considerable amount of interesting information has been collected regarding the spread of this turnip throughout the country, and the following very short summary may be of general interest.

Mr. Wm. Brodie, who was a grieve at Old Deer, was evidently responsible for starting the flow of what has turned out to be one of the main streams in the distribution of the turnip throughout the country. He got seed from Inverquhomery about 1838, took it with him to New Pitsligo, and gave a seeding to Mr. Alex. Mackie, Greenspeck, who was ground officer on the estate. Mr. Mackie grew and seeded it and sold it as the "Greenspeck Neep." His son, Mr. Thomas Mackie, followed his example, and the turnip is now known in the district as "Tammie Mackie."

About 1888 Mr. Alex. Robb took seed with him from New Pitsligo to Bulwark. He also grew and seeded it and it became known as the "Bulwark Champion" and latterly as "Sandy Robb." From this centre it has spread to many different districts. Mr. Wm. Philip, Kinmundy, introduced it about 30 years ago into Skene and surrounding parishes, and from these it gradually spread to Inverurie, Keig, Kemnay, Alford and Whiterashes, &c.

Mr. Alex. Mair, Cullerlie, Echt, also got it from Bulwark about 30 years ago, and from there it spread to Turriff and Culsalmond. Mr. Alex. Bennet got seed from Mr. Mair and took it with him to Newhall, Muchalls, about 25 years ago and seeded it, and it is now largely grown in the surrounding district and known as the " Newhall Neep."

From Bulwark it also spread to Udny, Ellon, Fyvie and Kinnellar. From the last it further went to Forgue, Ythan Wells and Turriff.

It is also grown in Cruden and surrounding parishes, where it is known as " Geordie Henry." Mr. Henry first got seed about 1883. It came originally from Mr. J. Lendrum, near Bullers of Buchan, where it had been grown since about 1843. So far no connection has been traced between Inverquhomery and the Cruden distribution, but the parishes are adjacent.

The turnip is also grown in Banffshire—Marnock, Cornhill, and Deskford, where it was introduced about 80 years ago from Aberdeenshire and is known as " Russell's Neep."

An interesting rumour that was heard from at least three different districts is that " the turnip came from abroad; it came into Peterhead in a boat."

As Mr. Bruce was a shipowner at Peterhead it was thought there might be some truth in this, and enquiries were made in Denmark, Norway and Sweden, but evidently no such variety is grown in any of these countries. Mr. C. Stahl, who visited Craibstone last year, was able to state that the yellow turnips grown in that country were mostly of the tankard type. Mr. Nilsson Leissner, Sweden, kindly sent samples of the varieties grown in Sweden, but they were also found to be of the same tankard type. Mr. Albert Riple, Agricultural Adviser to the Norwegian Government, Newcastle, who kindly made enquiries in Norway, states that the following yellow varieties are grown in that country—Ostersundom, Greystone, Bortfelder and Dales Hybrid. Enquiries were also made in Orkney and Shetland, but no trace could be found of the purple top having been grown there. Another statement made was that the turnip came from Devon about 80 years ago, and that it was sent to both New and Old Pitsligo, of which Sir John Hepburn Stuart Forbes, who also owned an estate in Devon, was at that time proprietor. This statement, however, does not seem likely as (1) the turnips grown in Devon are mostly of the early soft type and (2) there is a heavy cropping early turnip grown and seeded in the Old Pitsligo district which is recognised by farmers there as being the produce of the one sent from Devon.

Types of Purple Top Yellows.—There are several quite distinct varieties of purple top turnips, and these may be divided into two classes according to the colour of the bottom and flesh.

A. *White bottom and white flesh.*—All the varieties included in this group are of the quick-growing soft type which are specially suited for use early in the autumn. The bulbs grow well out of the soil.

Greystone has a globular to a flattish bulb which is mottled with different amounts of purple on the top. The shaws are usually abundant.

Purple Top Mammoth grows a large globular bulb with a dark purple top. It also has comparatively large shaws.

Lincolnshire Red, Red Paragon or Beefheart also grow a large bulb of a somewhat flatter shape with a light red top, but the amount of shaws is less.

Red Tankard or Ostersundon are of the long tankard shape, with a red top and a limited amount of shaws.

B. *Darker coloured bottom and flesh.*—This group includes most of the ordinary purple tops, variously called Purple Top Aberdeen, Purple Top Scots or Purple Top Bullock Yellow, or bear a seedsman's distinctive name. They are mainly of the globular shape, a proportion, however, being somewhat tankard or very rarely flattened. They nearly all grow well out of the ground. The shade of colour varies somewhat, both in different samples and also within a sample, some being very dark purple and others light purple or pink. The bottom is usually lemon in colour, although some bulbs have a pinkish tinge. The flesh varies considerably in different bulbs even in the same sample. Some are of a lemon colour and quite firm, while others are somewhat lighter and spongy in different degrees. The amount of shaws also varies considerably. In northern stocks they are generally abundant, while in southern stocks they are usually somewhat scant. This, however, is by no means constant.

Although the Bruce would be included in this group, it differs in several respects from the general type.

Characteristics of the Bruce.—*The Shaws.*—There are considerable differences both in the amount and shape of the shaws. In some cases they are plentiful and more or less upright in habit, but in a good many other cases they are less plentiful and almost horizontal. A very distinct characteristic not often seen in other varieties of purple top turnips is that in the majority of cases there is a distinct purple colour in the ribs and veins of the leaves, of varying intensity in different bulbs. There does not, however, appear to be any connection between the amount of colour and resistance to disease.

In a very few cases the leaves are identical with those of a swede, although the bulbs are purple top yellows. In fact, several farmers in quite different districts have expressed the opinion that as the Bruce is so firm and keeps so well in spring it is a cross between a green top yellow turnip and a purple top swede. There may be something in this opinion.

Shape of the bulbs.—There is considerable variation in the shape of the bulbs. A few are globe-shaped with a fine rounded shoulder. A large proportion, however, are flat in different degrees, while a few are of a distinct tankard type. Most of the bulbs grow well into the soil.

Colour of the top.—While the general colour of the top of the bulbs is purple, in a great many cases it is almost black, while others are lighter, a few being reddish-purple. A notable feature is that in most cases underneath the outer bloom there is a distinct bright violet colour under which there is a green layer.

The colour varies somewhat on different soils. For example, last year at West Fornet, Dunecht, in one field which is of a peaty nature many of the tops of the bulbs were of a distinctly lighter colour; in another field on the same farm, where the soil is a sharp loam and where the conditions are naturally of a drier nature, the colour of the top of the bulbs was much darker, a large proportion being almost black. So marked was the difference that one would have said they were of a different variety, although in both cases the seed was said to have come out of the same bag.

This example is made still more interesting as the same seed was supplied to another farmer and was sown on a field which was peaty at the lower part and a sandy loam at the other end of the drills. Here again the turnips grown on the peaty soil were distinctly lighter in colour than those grown on the harder soil.

It might be expected that the very dark purple colour of the top would indicate a firm flesh and high resisting power, but this was not always the case, as both the firm and the spongy bulbs include those that are dark and those of a lighter colour. Similarly, some of the lighter coloured turnips are quite as resistant to finger-and-toe as the dark ones.

Colour of the bottom.—In the majority of bulbs the bottom is of a dark lemon colour. In several cases, however, there is a green band of varying width, sometimes up to one inch wide, between the purple and the lemon. In other cases the bottom has patches of mottled light pink on it, sometimes covering it all.

The flesh.—The flesh also varies somewhat, but in most cases it is of a lemon colour, firm and juicy, and the bulbs often crack when the borer is inserted to take a sample. This cracking is usually considered a sign of quality. In a few cases the bulbs are spongy, indicating that there is need for selection in this respect. One of the chief characteristics of the Bruce is its superior keeping quality; it remains firm and juicy well into spring. This feature was remarked on by several farmers who grow it. In February 1930, 25 borings of several varieties were taken and classified into spongy, firm and intermediate. The following table shows the classification :—

	Spongy.	*Intermediate.*	*Firm.*
Ordinary Purple Top 1	13	3	9
Do. do. 2	9	6	10
Do. do. 3	9	3	13
Do. do. 4	14	5	6
Sittyton Purple Top	9	6	10
The Bruce	1	7	17
Challenger Green Top	3	3	19
Glenloggie Green Top	7	7	11

The percentage of dry matter is usually taken as indicating the quality of a turnip. The following table shows the dry matter content in the 1930 crop of a number of types compared with the Bruce (it should be noted that in 1930 the average proportion of dry matter was about 1·5 per cent. below the normal) :—

	Varies from % %	*Average.* %
Purple Top Aberdeen or Scots Bullock (24 samples)	8·3 to 10·2	9·4
Green Top Golden Yellow bottom as Challenger (8 samples) ...	8·8 to 10·5	9·6
Green Top Lemon bottom as Glenloggie (12 samples) ...	8·8 to 10·3	9·5
The Bruce (36 samples)	9·5 to 10·8	10·1

These figures show the considerable variation among different samples of all the different types of turnips. In selecting bulbs for seed the shape is usually the chief characteristic that is considered, but if careful attention were paid for several generations to the dry matter content as well, improved strains should result.

There is considerable diversity of opinion among farmers regarding the feeding quality of the Bruce, especially for the production of milk. Adverse criticism of its value in this respect frequently appears to be based on the critics' opinion on the quality of ordinary purple tops, which are often spongy and foggy, and do not produce as much dry matter per acre as the same bulk of good quality green top yellows. Others, on the other hand, declare as emphatically that the Bruce is better than Green Top. In these cases it is likely that more spongy Green Tops were used and provided a smaller amount of dry matter than the Purple Tops.

In feeding trials carried out by the three Scottish Agricultural Colleges, and described by Dr. Lauder in a previous issue of *The Scottish Journal of Agriculture*,[1] it is shown that there was no difference in the feeding value of varieties of swedes with a high and low dry matter content when the same amount of dry matter was given to each lot of animals. Similarly, in a trial carried out at Craibstone several years ago there was no difference in the amount of milk produced by animals fed on swedes and yellow turnips when the same amounts of dry matter were used in each case.

In order to get some definite information regarding the comparative value of the Bruce for milk production, a small feeding trial was carried out last spring. Four cows were used, each pair receiving equal quantities of Challenger and the Bruce respectively. The amount of dry matter in both cases was similar. At the end of each week for three weeks each lot was transferred to the other variety, thereafter each lot was kept on the same variety for periods of three weeks and finally transferred to the other variety for one week. Each cow was therefore kept on each variety for a period of five weeks. The feeding otherwise was the same throughout.

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[1] Vol. X, No. 4, p. 428.

The following table shows the amount of milk obtained during each week from each cow, and it will be seen that there was practically no difference in the individual yields of any of the cows as between Challenger and the Bruce.

The Bruce Purple Top Yellow Turnip.

Comparison with Green Top Yellow (Challenger) for Milk Production.

Week ending,	BLUIE.		JOY.		ANN.		KATHLEEN.	
	Green Top.	Purple Top.	Green Top.	Purple Top.	Green Top.	Purple Top.	Green Top.	Purple Top.
1930.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
January 18 ...	309¾	...	177½	...	...	176	...	232½
,, 25 ...	...	321½	...	192½	173	...	213	...
February 1 ...	319	...	191¾	...	...	176¾	..	236
,, 8 ...	...	311	...	193½	177¾	...	248	...
,, 15 ...	...	319¾	...	193¼	150¾	...	272½	...
,, 22 ...	...	311	...	204½	164½		267½	...
March 1 ...	305½	...	196½	...	...	156	...	273¾
,, 8 ...	307½	...	195	...	...	158½	...	273
,, 15 ...	300½	...	201½	...	...	160¾	...	269¼
,, 22 ...	...	285¼	...	192¼	158	...	255¼	...
	1,542¼	1,548½	962¼	976	824	828	1,256¼	1,284½

Cropping capacity.—The comparative cropping capacity of varieties of turnips depends to a considerable extent on whether or not the bulbs are affected with finger-and-toe, and, if so, on the severity of the attack. The following are typical results obtained in different trials under each condition :—

	Per acre.					
Soil :	*Badly affected.*		*Affected.*		*Healthy.*	
	tons	cwt.	tons	cwt.	tons	cwt.
Bruce	23	5	21	3	23	11
Challenger Green Top	3	0	12	0	21	5
Glenloggie Green Top	6	16	17	0	23	17
Purple Top Aberdeen	1	16	10	5	23	0
Sittyton Purple Top		18	5	17	24	4

The true value of a crop of healthy turnips is, however, the amount of dry matter produced per acre. A good-looking turnip crop of comparatively large spongy bulbs growing well out of the ground may really be a poorer crop with less food material per acre than another crop which does not look so well, but where the turnips are comparatively small and firm and grow well into the ground. Taking the above example, where there was no finger-and-toe, we find that the true values of the varieties are as follows :—

	Crop per acre.		*Dry matter.*	
	tons	cwt.	per cent.	cwt.
Bruce	23	11	10·8	50·9
Challenger	21	5	11·3	48·0
Glenloggie	23	17	10·5	50·1
Purple Top Aberdeen ...	23	0	10·4	47·8
Sittyton Purple Top ...	24	4	9·8	47·4

Some farmers said the bulbs were small but others found that when sown early in the season they grew to a good size. It may be stated that trials carried out at Craibstone during the past 11 years show that the heaviest crops of both turnips and swedes are generally obtained when sowing is done early.

The following table shows the average results obtained with yellow turnips in these trials :—

Sown.	*Per acre.*		*Dry matter.*	
	tons	cwt.	per cent.	per acre.
May 15th	27	16	11·1	62·8 cwt.
,, 22nd	26	18	11·5	61·9 ,,
,, 29th	26	3	11·2	58·6 ,,
June 5th	25	8	10·9	55·4 ,,
,, 12th	23	9	10·5	40·2 ,,
,, 19th	20	7	9·5	38·7 ,,
,, 26th	17	18	9·7	34·7 ,,

Disease resistance.—Leaflet No. 77 of the Ministry of Agriculture and Fisheries says :—

> "No immune varieties are known, but from time to time the advent of a resistant swede or turnip has been heralded. Unfortunately, the claims made in the past on behalf of such varieties have in no case fulfilled expectations."

Does the Bruce come under this condemnation or have its claims fulfilled expectations?

The evidence we have is obtained both from experiment and practice, first from the plots at Craibstone and second from the large number of farmers who have tried it alongside other varieties on infected land.

During each of the five years that it has been sown on the infected plots at Craibstone on which turnips have been continuously grown for 16 years, it has been very much more resistant than all other varieties. It is not that it is immune—in fact only a small proportion shows no sign of the disease on the badly affected plot—but infection is in nearly every case almost entirely confined to the roots and the bulbs are very rarely affected, so that practically the whole crop is usable.

A considerable number of reports has been received from farmers who have grown the "Bruce," some for a long time, on land badly affected with finger-and-toe.

In some cases where part of a field was sown with ordinary turnips or with swedes there was a disappointing crop of

Drill 1. Drill 2.

Taken in September.

Drill 1. Drill 2.

Taken in December.

No. 1 Drill.—Ordinary Purple Top.

No. 2 Drill.—The Bruce.

unhealthy bulbs, whereas the bulbs of the " Bruce " sown alongside were sound.

In many cases seed of an ordinary variety was put in one box of the sowing machine while seed of the " Bruce " was put in the other; the result invariably was that the ordinary variety produced less than half a crop of diseased bulbs, while the Bruce was almost or entirely healthy.

In several cases where farmers had got only a small quantity of seed, they made it go as far as possible by mixing it with ordinary green top yellows. When singling they left as many purple tops as possible, and so were able to get many more bulbs than if they had sown the seed by itself. In these cases there was hardly a sound turnip among the green tops and scarcely a diseased one among the purple tops.

In order to get some information regarding the different stocks in the country, samples of seed were obtained from 26 different farms in several different districts. These were sown on the affected plots at Craibstone alongside ordinary varieties, including several " disease resisters " of both purple top and green top strains and also selections of the Bruce that had been made from bulbs grown on the affected plot in 1928.

All stocks of the Bruce were much better than the ordinary and " disease resisting " varieties, but there was a considerable difference in the resisting power of different stocks. All the selections from the infected plot were extremely good and also several of the other stocks. The available information regarding the least resistant stocks indicates that they had been growing for a good many generations on land which was not much affected, if at all, with finger-and-toe. These stocks, therefore, would appear to be gradually losing their resisting power. Of course, they were put to a very severe test on the infected plot, and it is quite possible that they might do much better under ordinary rotation conditions where infection would not likely be nearly so severe.

Those growing the Bruce for seed would therefore be well advised to grow their stock seed on an infected piece of ground in order to maintain, and if possible to increase, its resisting power.

An interesting point of view is brought to notice by Mr. J. F. Hockey of Kentville, Nova Scotia, who, writing on " Selecting Disease Resisting Turnips " in " Occasional Hints from the Dominion Experimental Farms of Canada," says :—

> " Investigations with the organism causing club root (finger-and-toe) have led to the belief that there may be several strains of it, and that one variety of swede (or turnip) may be resistant to several strains, but club severely when other strains are present in the soil."

This hypothesis appears to be quite feasible when we consider that finger-and-toe is prevalent under such different conditions as on dry thin soils and on damp deep soils, and may explain why the varieties that were claimed to be disease resisters under certain conditions failed under other conditions.

Size of Seed.—As in the case of most home-grown turnip seed, the seeds of the Bruce are usually very small, there being often a fairly large proportion of reddish coloured, immature seeds present. This is probably due to the necessity for cutting the crop early in order to save it from the birds. The area sown is small, and unless protected in some way from birds the seed would be all eaten in a short time.

Plants grown at Craibstone were covered with nets so that the seeds were fully ripe before they were harvested. The result was that the seeds were generally much larger than most of the locally grown samples. It was also noted that there was a considerable difference in the size of the seed from different plants. The following figures will give an indication of the relative size of the seeds of the Bruce and other purple top yellows :—

	No. of seeds in 1 lb.		
	Largest.	*Smallest.*	*Average.*
The Bruce—			
Locally grown seed ...	242,000	446,000	305,000
Craibstone selected ...	186,000	274,000	222,000
Ordinary Purple Top Yellows (possibly all south grown)	156,000	250,000	201,000
Early Purple Top Yellows (south grown)	188,000	229,000	208,000

It is usually considered that large seeds are superior to small seeds, and no doubt they sometimes are, as in the first instance the large seeds produce large seedlings which give the plants a good start, but (1) small seeded samples of the Bruce resist finger-and-toe better than large seeded samples of other purple tops, and (2) small seeded samples of a good strain may produce a heavier crop than large seeded samples of an inferior strain, as in the following examples where seeds of the Bruce selected from different bulbs are compared :—

	No. of seeds in 1 lb.	*Crop per acre.*	
		tons	cwt.
Sample No. 1	190,000	18	5
Sample No. 2	252,000	18	5
Sample No. 3	382,000	18	5
Sample No. 4	416,000	22	13
Sample No. 5	230,000	20	6

Here there is no connection between the size of the seed and the crop produced. Samples 1, 2 and 3 all produced the same crop although there is a considerable difference in the size of the seeds. Sample 4 produced the largest crop although the seeds are smallest, while sample 5 was intermediate. The size of the seed of different samples gives no indication whatsoever of its value. The strain is of more importance than the size.

When, however, we consider the value of the large and small seeds in a sample of the same strain, we find that the former are superior, as the following example out of many shows :—

	No. of seeds in 1 lb.	*Crop per acre.*	
		tons	**cwt.**
Large seeds from a sample ...	158,000	20	2
Small seeds from same sample	328,000	17	4

Although the seed of the Bruce is often small, it germinates well and there is always a good thick braird. Many farmers say they sow only about 1 lb. of seed per acre, and in one case as low as ¾ lb., and the plants grow thickly enough.

Thanks are extended to the many friends who so kindly and so willingly gave and helped to obtain information of assistance in conducting this most interesting enquiry.

RABBIT CULTURE.

John Sherborne,
President, National Rabbit Council.

The building up of a " stud " of hutch bred rabbits for the purpose of fur or wool production is a project which should receive the attention of farmers and smallholders. There is a regular market for pelts and carcases and also for Angora wool, and where, as is always the case on a mixed farm, the cost of feeding is negligible, rabbits can become a profitable side line. Green food, oats and hay in the summer, with roots and an occasional mash in the winter, provide all that is necessary to keep rabbits in healthy condition, and a stud of twenty to thirty adults can be attended to without serious addition to labour costs, or to the day's work.

Hutches can be stacked in either a closed or open shed, it being important to provide ample fresh air with freedom from draughts. The animals should be bedded on dry deal sawdust, and each hutch should be thoroughly cleaned out at least twice weekly.

Hutches for indoor rabbitries can be made very cheaply out of wooden boxes, which can be secured for a few coppers from a tobacconist or grocer. The size of these should be about 2 feet square and at least 20 inches high for a single medium sized rabbit. Breeding hutches must be larger, and for most varieties it is best to allow a floor space of about 8 square feet. Anyone who is fairly handy with tools can make the hutches with very little trouble. The best way to start is to nail three or four of the boxes one on top of the other. Then nail a length of 2″ × 1″ wood down either side. Make the door of 1″ wire netting on a 2″ × 1″ frame to fit inside the long lengths, to one of which it should be hinged, a turn-button fastening it on the other side. It will save a lot of time in feeding if each door covers an entire stack or tier of three hutches and if racks are fitted outside so that hay and green food can be given without opening the door. These hutches are quite suitable for an indoor rabbitry, but if the stock is to be kept outside, they should be made of strong tongued and grooved timber, with shutters which can be closed as a protection against rain. Rabbits can stand any amount of real cold and fresh air, but they must be shielded from draughts and wet.

The beginner has first to decide what variety of rabbit he will keep, and here I strongly advise specialising in one kind only; in my experience it is a rare exception for one breeder to succeed with two or more varieties. Public taste in furs alters with changing fashions, but the Chinchilla, Havana and Sable are amongst those pelts which enjoy a steady popular demand.

When the kind of rabbit to be kept has been decided upon, a purchase of an adult buck and two does should be made from a reliable breeder, the age specified being from eight to nine months. At this age the stock has reached full maturity and is ready for mating.

The period of gestation is thirty days, and a week before the doe is due to kindle she should be provided with an ample supply of hay in the breeding compartment of her hutch. She will then make preparations for the expected family by plucking fur from her own body, and with this will make a snug nest in readiness for the time of kindling. It is important that does should be undisturbed during pregnancy, and particularly the presence or barking of dogs in the vicinity of the rabbitry should be prevented.

It must be borne in mind that both before and after the birth of her young, the doe requires a larger quantity of food than at other times. Her ration should be gradually increased from a fortnight before kindling until the litter is ultimately weaned.

The correct time for weaning is about six weeks after birth, and it should be effected by removing the doe from her young and providing her with a new home in another hutch. The youngsters can then run together for a further period of six weeks or, if they show no disposition to quarrel, for a few weeks longer, after which they must be housed in separate hutches.

Especial care must be taken after weaning to see that the young rabbits are suitably and adequately fed. Whilst the doe is running with her family she appropriates the lion's share of the green food, which can be fed lavishly, but after her departure green food must be given sparingly at first or the youngsters will blow themseves out and develop " pot belly." The safest practice immediately after weaning is to give them ample dry food with a very small quantity of green food; this should be fed after they have satisfied their first hunger from the corn pot.

Where skimmed or separated milk is available it can be given daily to the doe whilst she is with her family and to the youngsters after the mother has been taken from them.

Abundant hay, which must be quite free from fust or mildew, should be supplied at all times to both adults and young stock.

A healthy doe normally has four litters a year, the average number per litter being about six, and if during the first year the breeder retains the young does from his initial litters for future breeding, he can build up a sufficient stock at a small cost.

The marketing of rabbit produce on sound economic lines has now passed the experimental stage, and the demand for rabbit meat and for undyed natural rabbit, or coney fur, is growing. A number of wholesale firms specialise in the purchase and disposal of rabbit carcases and are always willing to receive consignments either skinned or unskinned.

The price obtainable for skinned carcases is from 7*d.* to 1*s.* per pound, and if the pelt is retained and dried by the breeder he can secure an average price of about 5*s.* per pelt from animals killed when in full coat and good condition. Angora rabbit wool of first grade is at present realising about 28*s.* per lb.

Rabbits reared for pelt production should be killed when in full coat. This usually occurs in the months of October to March, and when they reach the age of six to eight months. Breeding operations in the case of the fur producing varieties should, therefore, be confined to the spring and early summer. between February and July. During this period three litters can generally be taken from each doe.

The actual cost of feeding to pelting age has been found by the National Institute of Poultry Husbandry to amount to under 4*s.* per head when all food supplied has been purchased. It is needless to stress the point here that in the case of a farmer or smallholder, this cost would be reduced greatly as waste products could be utilised to a large extent.

Angora rabbits of a good strain will yield from 7 to 10 ounces of wool per annum, although the cost of keeping this breed is higher than that of the fur varieties. This is due to the fact that in order to prevent matted coats they must be bedded on straw instead of sawdust, or kept in hutches fitted with false wire floors. However, a good profit can be made from wool production, notwithstanding the small extra expense this involves.

That there is considerable scope for the further development of the rabbit industry, whether for flesh and fur or for wool, is demonstrated by the figures of importations of rabbit products into this country. Over £3,000,000 was spent by Great Britain for rabbit carcases, furs and wool from foreign countries during the year 1930.

Rabbits, in common with other live stock, require regular attention, and profitable results can be achieved only by experience and by the careful study of their habits and needs; they are singularly free from any serious forms of illness or disease, and give less trouble to their owners than almost any other domestic animal.

The rabbit industry is being established on secure foundations, and its importance has been recognised by the Department of

Agriculture for Scotland, which has recently, in co-operation with the Development Commission, given a substantial grant for rabbit research; this grant has been supplemented by contributions from a large number of breeders throughout the British Isles.

A few years ago the National Rabbit Council was formed to encourage rabbit keeping and to promote the interests of breeders, and this body has done a great deal of useful work and has collected much valuable information both of a scientific and general character, which is at the disposal of its members. The annual membership fee is 5*s*., and anyone who contemplates engaging in rabbit culture will be well advised to link up with this organisation. The Hon. Secretary is Dr. J. N. Pickard, Animal Breeding Research Department, King's Buildings, West Mains Road, Edinburgh.

CHICK-FEEDING EXPERIMENTS.

H. F. Newbigin, N.D.D.,
Edinburgh and East of Scotland College of Agriculture; and
R. G. Linton, Ph.D., M.R.C.V.S.,
Royal (Dick) Veterinary College, Edinburgh.

This experiment—the fourth in a series of feeding trials with chicks—was carried out for the purpose of determining the relative values of complex and simple grain rations for growing chicks, and to note what effect the addition of separated milk might have on growth and subsequent egg production.

Eighty-eight sex-linked pullet chicks hatched on January 14th, 1929, were divided into four groups, two groups being fed on a complex (and expensive) grain mixture, and two groups on a simple (and cheap) grain mixture. Each group was subdivided, one lot being given separated milk to drink *ad lib.* and the other lot water. The mixtures given to the four groups were :—

TABLE I.

I.	II.	III.	IV.
Equal parts of: **Dari.** **Millet.** **Canary seed.** **Broken lentils.** **Broken peas.** **Broken rice.** **Cut groats.** **Coarsely ground maize.** **Coarsely ground wheat.** **Hemp.** ***Separated milk.***	**The same as No. I.** ***Water.***	Equal parts of: **Cut groats.** **Coarsely ground maize.** **Coarsely ground wheat.** ***Separated milk.***	**The same as No. III.** ***Water.***

The composition of these diets was as follows :—

	GROUPS I and II. *Complex Diet.* per cent.	GROUPS III and IV. *Simple Diet.* per cent.
Moisture	12·12	12·12
Crude protein	14·00	9·63
Ether extract	6·53	4·50
N. free extract	59·80	70·69
Fibre	5·13	1·40
Total ash	2·42	1·60

A weighed amount of the mixtures, more than sufficient for the day's requirements, was placed daily in boxes before the chicks so that they could eat as much as they desired. Each day's residue was weighed and the amount eaten calculated. Fine oyster shell was supplied in boxes and green food was given when available. When the chicks were a few days old they were allowed free range on the grass runs attached to each brooder, but the nutritive value of the grass during the early part of the year could not have been great.

The experiment was divided into four periods. Throughout period I, which lasted for 56 days, the chicks were kept on the rations already described. During period II, from March 11th to May 10th (60 days), the diet was changed and the chicks of all groups were given a mash composed of :—

Coarsely ground wheat	60 parts.
Coarsely ground maize	20 ,,
Sussex ground oats	20 ,,
Ground oyster shell	2 ,,
Steamed bone flour	1 part.
Common salt	1 ,,

During this period the milk and water conditions remained the same. Period III extended from May 11th to June 10th (31 days), and at the beginning of the period the birds of all groups were given water to drink, the use of milk being discontinued entirely. The first egg was laid on June 4th, and period IV constituted the egg laying trial, which lasted for 12 months. From the beginning of the experiment until the end of the second period each bird was weighed every five days, and thereafter two weighings were carried out at monthly intervals. At the end of the second period the birds were moved to the laying houses, which had grass runs attached.

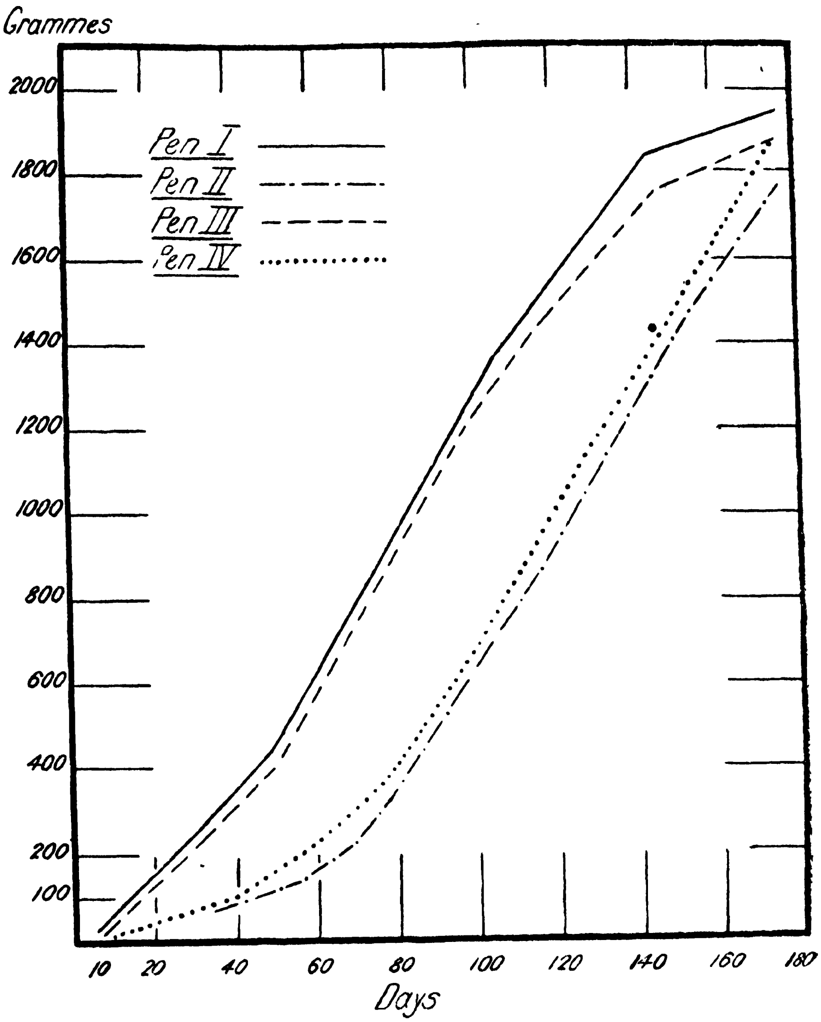
The following table gives the average weight of the birds in each group at the end of each period, their average gain for the period, and, for period I only, the average amount of food eaten per bird together with the amount of food eaten per gramme of live weight increase.

TABLE II.

	Group I.	Group II.	Group III.	Group IV.
	Complex Milk. Av. wt. grms.	Complex Water. Av. wt. grms.	Simple Milk. Av. wt. grms.	Simple Water. Av. wt. grms.
Av. initial weight	36·2	36·3	36·0	36·6
End of period I (Jan. 15th) ...	508·0	164·7	474·1	200·0
Average gain ...	471·8	128·4	438·1	163·4
Av. amount of food eaten per bird ...	1280·5	667·8	1218·3	764·8
Food eaten per grm. Live wt. increase	2·7	5·2	2·7	4·6
End of period II (May 10th) ...	1485·9	885·1	1443·4	898·3
End of period III (June 10th) ...	1856·0	1361·1	1767·0	1387·8
Final weights (July 10th) ...	1944·4	1767·2	1878·2	1843·4
Mortality	3	4	3	1

Discussion of Results.—*Period I.*—A study of Table II, together with the graph of weight increments appended, will show that the chicks allowed separated milk *ad lib.* made more rapid gains than the chicks restricted to water. This was to be expected in view of the results previously obtained by other workers. The milk-fed chicks at one time during this period actually had an average weight four times greater than the chicks allowed only water. Indeed the two water groups appeared stunted and unthrifty throughout the period. That milk has a beneficial effect when added to the diet of growing animals is well known, and numerous feeding experiments have been made to test the effects of adding milk to the diet of young chicks. Invariably the result has been that the milk has caused an increase in the rate of growth. Thus Elford (1) compared sour skim milk, sweet skim milk, sweet whole milk, sour whole milk, and water on five lots of chicks. The lowest mortality was obtained when sweet whole milk was used, and the highest mortality when sweet skim milk was added to the diet. Sweet skim milk caused the greatest rate of increase and water the least. The recent mass experiments in Scotland to test the effect of including milk in the diet of school children have provided striking proof that milk increases the growth of children as well as that of young growing animals. Woodman's experimental work with swine on the digestibility of foods seems to suggest that the addition of milk raises the digestibility coefficients of most of the food constituents. Woodman used whole milk (2).

In this experiment the consumption of separated milk caused the birds to eat nearly twice as much food as did those restricted to water, but the food eaten per unit of live weight increase was very much less, the difference in this respect between Groups I and II being very striking and the difference between Groups III



GRAPH OF THE WEIGHT INCREMENTS IN THE FOUR GROUPS OF CHICKS.

and IV being almost as great. In the case of the milk-fed groups the food consumed, 2·7 grammes per gramme of live weight increase, was the same in each group, and practically the same as that found by us with the same type of birds and under similar feeding conditions in a previous experiment, namely, 2·5 grammes of mixed grain consumed per gramme of increase when separated milk was added to the diet (3). In the present experiment the water-fed chicks in the two groups consumed 5·2 and 4·6 grammes of food per gramme of live weight increase respectively. A similar and definite reduction in the amount of food consumed per unit of live weight increase when milk was included in the daily ration was obtained by Blisset and Golding (4) in a series of feeding experiments with pigs, whole milk rich in butter fat being used.

When the chicks were four weeks old the birds in Groups I and II developed " leg weakness " ; the chicks in Groups III and IV were not affected, though they probably would have been but for the fact that as soon as this trouble appeared all the birds were given cod liver oil daily, this treatment being continued until the end of the first period (56 days).

The growth results obtained during this period showed that a complicated and expensive mixture composed of the seeds commonly sold for chicks produces no better result than a much simpler and less expensive diet of groats, maize and wheat.

One noteworthy feature during this part of the experiment was that, though all the birds were allowed free range on grass, the milk groups scarcely touched the grass, whereas the chicks in the water pens were much more energetic rangers, and, moreover, picked the runs bare.

Period II.—The change of diet made at this stage had a definite effect on the chicks, causing a more rapid growth in all the groups, but particularly in the water groups. This is clearly shown on the graph. Obviously, therefore, the new diet contained some constituent or constituents in which the previous diets were deficient and which was sought for by the water groups in the grass. The improvement in the rate of growth may have been attributable to the sodium chloride or the bone flour. It has been known for a long time that sodium chloride is necessary in the diet of chicks if normal growth is to be procured and the health of the birds maintained, and Carver, Buchanan and Miller (5) have expressed the opinion that the four elements required in greatest amount for growing chicks are calcium, phosphorus, sodium and chlorine. The recent work of Scott Robertson, Orr *et al* has emphasised the importance of sodium chloride in the diet of chickens (6). Reluctance on the part of some poultry keepers to add salt to the diet of their birds, referred to by Scott Robertson and his co-workers, is due to the unfortunate notoriety resulting from isolated instances of salt poisoning due to the use of refuse food material. In one instance known to the writers a flock of Indian Runner ducks died following the consumption of some bakery sweepings which were found to contain

30 per cent. of common salt. This and similar cases have been responsible for erroneous conceptions regarding the utility of salt.

Period III.—During this period when the milk was replaced by water there was a marked falling off in the rate of growth in the pens that had hitherto been receiving milk. The birds of Groups III and IV, which had been on water throughout the trial, continued to make steady and uninterrupted progress. It should be noted that toward the close of this period the birds of Groups I and III (milk groups) were preparing for egg-production, and as soon as this commenced there was a reduction in the rate of their body increase. On the other hand, the water groups, which started egg-laying later, continued on the same plane of increase, at least for as long as the birds were weighed.

Egg Production.—*Period IV* (June 1929–June 1930).—All the birds were trap-nested for twelve calendar months, each egg being weighed individually. The first egg was laid in Group I on June 4th, and from this date onwards all the groups were put on the following dry mash :—

Coarsely ground wheat	50 parts.
Coarsely ground maize	20 ,,
Sussex ground oats	10 ,,
Alfalfa	10 ,,
Fish meal	10 ,,

Table III gives the record of the eggs laid for each group

TABLE III.

Egg Record.

	Group I (milk).	Group II (water).	Group III (milk).	Group IV (water).
	(19 hens.)	(18 hens.)	(19 hens.)	(21 hens.)
First egg	June 4th	June 20th	June 5th	June 28th
Total eggs	2,708	2,623	2,934	3,012
Total weight in grammes ...	148,116	142,845	152,523	165,470
Average eggs per bird ...	142·5	145·1	154·4	143·4
Average weight of egg per bird in grammes ...	54·6	54·4	51·9	54·9

	Combined Milk Groups I and III.	Combined Water Groups II and IV.
Average eggs per hen ...	148·4	144·5
Average weight in grammes	53·8	54·7

No deaths occurred during the egg-laying trial, but in pen III one bird ceased laying after the first three months, having laid only twelve eggs; and one bird in pen IV never laid an egg and was destroyed. These two birds were not included when the average egg yields were determined. Practically every bird moulted in September-November, and this reduced the year's record very materially.

As is shown in Table III, the milk-fed birds began laying when they were four and a half months old, whereas the birds restricted to water were sixteen days later in water Group II, and 24 days later in water Group IV than the first egg-producer in milk Group I.

In regard to quantity and size of the eggs, no group shows to marked advantage over another, and while the average number of eggs per bird in the combined milk groups is slightly greater than that of the water groups, the average size of eggs is slightly less, but the differences between the individual groups is of no statistical significance or value.

It is to be noted that during period I there was a marked difference between the milk and water groups, but that when the diet was changed to a ration containing bone-meal and salt, the water groups made better progress. It seems justifiable to suppose that had the grain ration of period I been continued without the bone-meal and salt supplement, the advantage of the milk would have been more definite. Obviously, the value of milk must depend, at least in some measure, on the biologic value of the basal ration.

An interesting and significant feature was the fact that although the milk chicks grew very much more rapidly than the water chicks during the early part of the experiment, during periods III and IV the water chicks were distinctly the finer-looking birds. They carried themselves better, seemed to be in a better condition, and their plumage appeared to have more bloom. The more pleasing appearance of these birds was very obvious and was frequently commented upon by visitors to the Station.

The use of milk was continued for sixteen weeks, and this prolonged period probably accounts for the " dry " and somewhat " overgrown " appearance of the birds in the milk groups—in contrast to the sleek appearance of the water groups—during the later stages of the experiment.

It is the general belief that the maximum benefit from milk is to be obtained during the first four or five weeks after hatching, and this experiment gives support to the contention that if milk is used for too long a period it may over-stimulate growth to the detriment of the body. In this connection Carver, Buchanan and Miller (5) draw attention to the fact that a high corn and milk content in a diet often results in too rapid growth, and too early a sexual maturity of the pullets, laying commencing at four and a half to five months. This results, they say, in lowered vitality. The length of period for milk-feeding, however, must to a certain extent be governed by the nature of the rest of the diet.

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FIELD TRIALS with "GOLDEN WONDER" and "KING EDWARD VII" POTATOES.

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IN 1929 three Scottish potato growers were successful in raising small crops of the variety Golden Wonder almost free from visible symptoms of mosaic and were granted " stock " seed certificates. The vigour and high yields obtained from these relatively healthy strains confirmed the impression that virus diseases were mainly responsible in this, as in other cases (1 and 2), for the poor yields usually obtained.

The writer arranged to test the cropping power of one of these improved strains of Golden Wonder against that of the variety King Edward VII. This latter variety was chosen as being perhaps the most popular variety south of the Tweed, and an ordinary commercial T.S. certified strain, representative of the standard of the bulk of seed of this variety grown in England, was selected. The particular object of the trial was to determine whether the English grower would still be well advised to continue the planting of " Commercial " seed of the non-immune variety King Edward in preference to an improved strain of the immune Golden Wonder. It seemed advisable also to ascertain just what advantage would accrue in the case of each variety from the use of " stock " certified seed as against ordinary commercial T.S. certified seed, so three separate trials, in adjacent plots, were ultimately laid down as follows :—

Trial (*a*). " Stock " seed *vs* commercial seed of Golden Wonder.

Trial (*b*). " Stock " seed of Golden Wonder *vs* commercial seed of King Edward VII.

Trial (*c*). " Stock " seed *vs* commercial seed of King Edward VII.

Source of Seed and "Lay-out" of Trials.—The " stock " seed of both varieties was obtained from Banffshire, but owing to the unusually high standard of other local stocks of Golden Wonder, it was necessary to go elsewhere to obtain a representative sample of ordinary T.S. commercial seed for comparison. This commercial seed was therefore secured from the Biggar and Broughton districts. At the outset it should be made clear that the trial was in no sense a test of the relative value of these areas for seed producing purposes, and that had it been possible both stock and commercial seed would have been obtained from the same district. The history of the commercial seed of Golden Wonder is nevertheless of interest as an illustration of the varying conditions under which seed potatoes are produced. This seed originated, as a commercial stock, from a Banffshire farm, where, by rigorous rogueing out of diseased plants, the stocks had been maintained with only 25 per cent.

to 30 per cent. of severe mosaic present—a considerable improvement on the seed ordinarily available to growers. Seed from this partially rejuvenated crop was despatched to a farm near North Berwick in 1926, where it was grown for three years. In 1929 it was again transferred to Biggar, where more than 99·9 per cent. of the plants in that year showed mosaic in a severe form, great difficulty being experienced in selecting forty plants for special propagation out of a two-acre crop. It was from this field that the commercial seed of Golden Wonder was obtained for the present trials. The stock seed of both varieties was received on March 17th and was boxed at once; but there was an unfortunate delay in receiving the commercial seed, which arrived only on April 17th. Planting was carried out on April 28th and 29th, so that the stock seed had the considerable advantage of six weeks' boxing as against the fortnight available for the commercial seed. In all these cases the seed had been graded over a 1¼ in. and through a 2⅛ in. riddle. Finally, just before planting, a further quantity of both stock Golden Wonder and commercial King Edward VII was received and was not boxed at all.

Each of the three trials consisted of eight replications of unit plots, these being single rows of 54 tubers planted 15 in. apart. There were thus sixteen drills in each trial, of which eight drills of one strain alternated with eight of the other strain under test. The two end plants at each end of a drill were not included in the trial but sufficed to reduce any error due to marginal effects, whilst each complete trial was similarly flanked by two drills of the same variety for the same purpose.

The ground covered by the three trials was reasonably uniform, as is shown by Table I, in which the yield of each unit drill of 50 plants is given. This uniformity in soil conditions makes it possible, in those few cases where other conditions were also similar, to make cross comparisons from one trial to another.

TABLE I.

Total Yields in lb. per unit plot of 50 plants.

Trial A. Golden Wonder. (" Stock " seed starred.)

	*		*		*		*		*		*		*		*
66	84	70	77	68	82	63	89	72	85	73	87	71	92	77	82

Trial B. Golden Wonder *vs* King Edward. (Former variety starred.)

*		*		*		*		*		*		*		*	
71	80	73	81	68	70	77	78	78	70	65	70	76	81	70	80

Trial C. King Edward. (" Stock " seed starred.)

*		*		*		*		*		*		*		*	
108	108	97	94	95	89	101	94	93	95	96	89	98	100	97	97

Trial A. "Stock" Seed *vs* T.S. Certified Seed of Golden Wonder.—Throughout the growing season the advantage obviously lay with the stock seed both in vigour and relative freedom from virus disease symptoms. Only careful examination disclosed the faint mottle which was general on the "stock" foliage, but the commercial seed showed unmistakeable mosaic on every plant. The stock seed plants flowered earlier and more prolifically than did the commercial seed plants. Lifting took place on October 1st with the following results :—

Stock seed.—Mean yield per unit plot (50 plants) = 84·75 ± 1·1 lb.
Commercial seed.— Do. do. = 70·00 ± 1·0 lb.

The difference in these mean yields equals 14·75 lb. per 50 plants, which is more than nine times the probable error of the difference of the means (± 1·5 lb.), so that one can be confident of the considerable superiority of the stock seed over the commercial strain in respect of total yields obtained. Since each unit plot measured $\frac{1}{303}$ acre the yield per acre amounts to :—

10 tons 18 cwt. from the stock seed, and
9 tons 9 cwt. from the commercial seed,

or a yield of 1 ton 9 cwt. in favour of the stock seed. The proportion of ware to total crop was also higher for the stock seed, being 85·7 per cent. as compared with 77·98 per cent. in the case of the commercial seed. What is still more important is that the actual amount of ware tubers lifted from the stock seed was 72·75 lb. as against 54·5 lb. from the commercial strain; an increase of 18·25 lb. per 50 plants, or 2 tons 9 cwt. more ware per acre.

Trial C. "Stock" Seed *vs* T.S. Certified Seed of King Edward VII.—At no time during the season was any difference noted between the two strains of King Edward seed, either in vigour or virus infection; the latter was indeed nothing more than the faintest mottling or "miffiness," which certainly would not be observed by casual inspection. When lifted on October 2nd the yields fully confirmed the impression that the one strain was as good as the other, notwithstanding the different classes of certificates issued.

Stock seed.—Mean yield per unit plot (50 plants) = 98·12 ± 1·11 lb.
Commercial seed.— Do. do. = 95·75 ± 1·40 lb.

The difference between these mean yields is only 2·37 lb., which is less than twice the probable error to which it is exposed (± 1·7 lb.), so that there is no justification for regarding the difference as other than an accidental one. The yields per acre are as follows :—

Stock seed = 13 tons 5 cwt.
Commercial seed = 12 tons 19 cwt.,

a difference of 6 cwt. in favour of the stock seed. The proportion of ware to total crop is about the same in both strains, being 79·5 per cent. in the stock seed and 76·6 per cent. in the commercial seed. The mean actual weight of ware lifted is 77·9 ± 0·7 lb. from the unit plot of stock seed and 73·4 ± 1·4 lb. from the commercial seed. This difference of 4·5 lb. being three times the probable error of the difference of the means must be considered mathematically significant; it amounts to over 12 cwt. more ware per acre from the stock seed than from the commercial seed. It seems reasonable to attribute this increased production of large tubers to the difference in the length of time during which the stock and commercial seed were boxed, i.e. six weeks and two weeks respectively.

Trial B. "Stock" Golden Wonder *vs* T.S. Certified King Edward VII.—Neither sample of seed for this trial had been boxed, but that of the Golden Wonder had been graded over a 1¼ in. and through a 2⅛ in. riddle, whereas, unfortunately, the King Edward seed had only passed over a 1¼ in. and through a 2 in. riddle. The latter seed was definitely a poorer sample than the commercial seed used in Trial C, although received from the same firm. Throughout the growing season the Golden Wonder appeared more vigorous than the King Edward seed, but when lifted on October 1st the yields were found to be as follows :—

Golden Wonder.—Mean yield per unit plot of 50 plants			=72·25±1·07 lb.
King Edward.—	Do.	do.	=77·42±1·60 lb.

The difference (5·17 lb.) is 2·7 times the probable error to which it is exposed (±1·9 lb.). Although it seems probable that the advantage in cropping power lay with the King Edward, the odds against its being an accidental result are not high enough to warrant any dogmatism. In tons per acre these yields become

Golden Wonder=9 tons 15 cwt.,
King Edward=10 tons 9 cwt.,

a difference of 14 cwt. in favour of the King Edward. The proportion of ware to total crop was 83·9 per cent. for the Golden Wonder and 81·6 per cent. for the King Edward, but this position was reversed when the actual amounts of ware produced were considered, these being 60·6 lb. and 63·1 lb. respectively per 50 plants, or 8 tons 3 cwt. 3 qr. 21 lb.; and 8 tons 10 cwt. 2qr. 23 lb. respectively per acre. The King Edward seed thus produced nearly 7 cwt. more ware per acre than the improved strain of Golden Wonder.

Discussion of Results.—The superiority of the stock seed of Golden Wonder over the commercial strain is quite evident whether total yields, proportion of ware to total crop, or the actual weight of ware per acre are taken. The difference in the length of time the two classes of seed were in boxes unfortunately complicates the interpretation of the results, and it is not possible to say to what extent the increased yield of the stock seed is due to its relative freedom from virus symptoms, or to the extra time allowed for sprouting. Nor can the latter effect be estimated by comparing the yields of the boxed stock seed in Trial A and the unboxed stock seed in Trial B, since the latter was in competition with the variety King Edward and the degree of interference between these two varieties is entirely unknown. It seems, however, to be clear that boxing seed of the variety Golden Wonder has a marked effect on its cropping power.

The results of Trial C with the variety King Edward indicate that little advantage is to be gained from the use of stock seed in preference to a good commercial strain, but there can be no doubt that the commercial strain used in this trial was much better than the average sample on the market. In this case also the differences in size of set planted and in length of boxing period, as well as the possible varietal interference, prevent any comparison with the average sample of commercial seed of King Edward used in Trial B.

A fairly accurate comparison, however, can be made between the yields of the stock seed of Golden Wonder in Trial A and the stock seed of King Edward in Trial C, since the sets used were of similar size and origin and had been boxed for the same length of time; moreover, in neither case was there any competition with another variety.

Stock seed Golden Wonder per unit plot of 50 plants		= 81·75 ± 1·1 lb.
Stock seed King Edward VII	do.	= 98·12 ± 1·11 lb.

The difference of 13·37 lb. per 50 plants grown amounts to 1 ton 16 cwt. 19 lb. per acre in favour of the stock King Edward.

The main object of these trials, however, was to compare stock seed of Golden Wonder with an average sample of commercial seed of the variety King Edward, as in Trial B. In this case, the only difference in the two lots of seed was that the former had been graded over a slightly larger meshed riddle than the latter. As has been seen, the advantage on the whole lay with the commercial King Edward seed, both in total crop and in weight of ware lifted per acre, although the great improvement in the strain of Golden Wonder used over commercial seed stocks is beyond question. Heavy cropping, on the other hand, cannot be the sole explanation of the popularity of the variety King Edward, for several varieties crop at least as well and, in addition, are immune from wart disease.

The following reasons have been suggested to the writer for its popularity with hotelkeepers :—" King Edward keeps white for a long time after steaming or boiling. Steaming is the usual method of cooking in hotels and restaurants, and it is noteworthy that some varieties which keep white after boiling have a tendency to blacken quickly after steaming. King Edward tubers are so regular and uniform in outline and shape that there is very little loss when they are cleaned and peeled in a machine. On the other hand there is considerable loss with a variety like Kerr's Pink. As a general rule English grown potatoes cook drier than those grown in Scotland. King Edward tubers grown in England cook reasonably dry, remain whole after cooking, and do not break up into small pieces. Finally the King Edward tubers are distinctive owing to the colour markings on the skin."

The writer understands that a " waxy " or " soapy " variety such as King Edward is in demand in the chipped potato industry owing to the prevalent belief that less fat is absorbed in frying than is the case when a " mealy " variety such as Golden

Wonder is used. This belief is quite erroneous, as was shown by careful laboratory tests in which lots of 100 grams of freshly peeled " chips " were fried in known weights of lard at 200°C. for varying lengths of time, the lard afterwards being weighed at the same temperature. Such differences as were found were in favour of the Golden Wonder, and in any case there can be no doubt that, if fried at once after chipping, the mealy variety is as economical in fat as the soapy one. Curiously enough, though, if the " chips " were allowed to dry for several hours before frying, there was some indication of a higher absorption of fat in the Golden Wonder.

The chipped potatoes made from Golden Wonder cooked quicker and were heavier than those made from the variety King Edward. This latter fact led to a determination of the dry matter content of the two varieties. The procedure adopted was that recommended by the Food (War) Committee of the Royal Society (3); the mean of eight results giving 27·4 per cent. dry matter for the Golden Wonder and 21·19 per cent. for the variety King Edward. These are reasonably near to the figures 27·24 per cent. and 20·94 per cent. obtained for the same two varieties by the collaborators in the Report of the above Committee. On this basis the total dry matter produced per acre by the variety King Edward VII in Trial B was 2 tons 3 cwt. 3 qr. 26 lb., whilst 2 tons 13 cwt. 1 qr. 12 lb. of dry matter was produced by the smaller crop of Golden Wonder, or an increase of 21 per cent. in favour of the latter variety. Since the Royal Society Committee also showed that Golden Wonder gave the highest percentage of nitrogen, both in tuber and in dry matter, of any variety tested, it is safe to claim that the smaller crop of Golden Wonder produced considerably more food per acre than did the variety King Edward. Furthermore, the mealy quality of the former is due to high starch content and not, as is stated to be the case in some varieties, to low protein content. The potato grower, however, cannot be expected to regard this enhanced food value with more than a somewhat detached interest unless he can claim a higher price for Golden Wonder than for other varieties. This appears to be the case in Scotland, but in England and Wales the variety is rarely quoted and would almost certainly not command the price offered for the variety King Edward—a demonstrably poorer quality potato. Until this is remedied there seems little hope that even the improved strain of the variety Golden Wonder will attain the degree of popularity which its immunity to wart disease, relative resistance to blight, excellent food value and cooking qualities should command.

The fact that the variety Golden Wonder can be produced and maintained, though at the cost of considerable care and expense, free from all except the mildest symptoms of mosaic, should be more widely known. The stocks have been established by rigorous selection and rogueing, since it has been found that rogueing alone will maintain, but not improve, the health of the stock. Under the conditions obtaining in East Lothian—and doubtless also in other localities—the diseases spread extremely rapidly if plants showing infection are present in the crop. In such districts the only practicable means of maintaining the health and vigour of a stock is to begin with the best available seed, having no diseased plants which can serve as a source of infection for the remainder of the crop. The improved strains of Golden Wonder, such as that used in the present trials, which is being marketed for the first time this year, contain no plants showing severe mosaic. They should, therefore, not degenerate unless infected from outside sources, e.g. mosaicked groundkeepers.

The writer wishes to acknowledge his indebtedness to Mr. John Chisholm, of Gibston, Huntly, Aberdeenshire, for presenting stock certified seed of Golden Wonder and King Edward VII for this trial; to Professor R. G. White of this College for extending the necessary facilities on the College Farm near Bangor, and to Mr. A. Millar, Seed Testing Station of the Department of Agriculture for Scotland, for suggestions in planning the experiments. Acknowledgments are also due to Messrs. J. F. Currie and G. L. Turner for assistance in planting and weighing the produce of the trials.

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LABOUR COSTS ON TWO ABERDEENSHIRE FARMS.

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THE value of cost accounting in agriculture has been criticised severely during the past few years, but it is undeniable that much useful information may be obtained from the study of the data obtained by this method.

This paper is devoted mainly to the labour requirements and distribution of labour on typical dairy farms in the County of Aberdeen. It has been stated that on dairy farms the total labour requirement is determined by the strength required for milking, and that the organisation should be such that the best use is made of this labour during those periods when it is not required in the byres. It is therefore interesting to note the organisation adopted on typical farms in order to utilise this labour.

In the neighbourhood of Aberdeen a large number of the farms are engaged in the production of milk, either for the wholesale or the retail trade, but it is also common to find several other enterprises developed on this type of farm. The most common enterprises are poultry and sheep, and these are combined in differing proportions. The cropping of the farms is also varied as regards the amount of land under grass either of a permanent or semi-permanent nature; but on dairy farms it is seldom found that much crop is sold, the large proportion being used for stock feed, and only that surplus to requirements finding its way to the market.

Where dairying and other enterprises are combined, the system of cropping practised may be relatively intensive or relatively extensive. The cropping system may include much grass, in some cases up to about 70 per cent. of the farm, while on the other hand only 40 to 45 per cent. of the farm may be in grass.

Cropping.—The two farms selected for the purpose of this paper had 49 per cent. and 37 per cent. of their total acreage under crop, and although this is by no means extreme it is thought that the organisation of these two farms may bring out useful and instructive comparisons and contrasts. The soil of both farms is very similar and little difference in yield of crops is experienced.

The distribution of the cropped area also shows some difference. The farm having the low proportion of cropped area had also the low proportion of green crop. The table below shows the cropping system of both farms.

TABLE I.

	Percentage of Crop.	Green Crop as percentage of Crop area.	Green Crop as percentage of total acreage.
Farm 1	49	31	15·4
Farm 2	37	30	11·1

Stocking.—As might be expected, the stocking is more varied than the cropping. Farm 1 is mainly stocked by cattle, i.e. cows and heifers, with a few sheep, but farm 2 carries in addition to cows a fair covering of sheep. Table II gives the stocking in cattle and sheep weeks and also in live stock unit[1] weeks per 100 acres.

TABLE II.

	Cattle (Cows, Heifers, &c.).		Sheep and Lambs.		Total Live stock unit weeks.	Average number of Poultry.
	As cattle weeks.	As live stock unit weeks.	As sheep weeks.	As live stock unit weeks.		
Farm 1	1,384	1,384	395	56	1,440	206
Farm 2	792	792	3,487	498	1,290	125

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[1] Orwin. *Farming Costs*, page 90.

Pigs on both farms are negligible, as they are kept only for eating any house refuse and play no part in the organisation of the farm.

Labour.—The labour used on the farms, given in Table III, shows great dissimilarity, but this again might be expected owing to the relatively extensive system in operation on farm No. 2.

TABLE III.

(Per 100 acres.)

	Man labour.	Woman labour.	Man labour (other than milking).	Labour on milking.
	hours.	hours.	hours.	hours.
Farm 1	7,418	1,261	7,418	1,261
Farm 2	6,284	739	5,852	1,171

On farm 1 woman labour only is employed for milking but on farm 2 a man is also engaged in milking, so that part 2 of the table gives a more accurate picture of the labour employed.

The number of cows in milk on the farms average 17·5 and 14 per 100 acres respectively, hence the time required per cow on the two farms is 12 and 14 minutes per day or 72 and 83 hours per year. For attending to the cattle, i.e. cows in milk, cows and heifers, the time occupied was 2,673 per 100 acres or 103 hours per live stock unit year on farm 1, but on farm 2, where the cattle population is composed only of cows (with the exception of one bull), the time required per cattle unit year was 113 or 1,695 hours per 100 acres. From these figures it is possible, in one case, to give the labour requirement per cow year. Farm 2 requires 113 hours for attending one cow and 83 hours for milking one cow, making in all 196 hours or 24·5 days of eight hours each. It is interesting to note that this figure is exactly that issued by Ruston as the labour requirement for Yorkshire farms.

From a set of records covering only one year the data are not thought to be sufficient to justify giving labour requirements for individual crops, but an analysis of the requirements per acre, and per crop acre, may be interesting and instructive. Farm 1 required 4,383 hours per 100 acres; this represents 43·8 hours per acre and 89 hours per crop acre. Farm 2 had a requirement of 3,879 hours per 100 acres, an equivalent to 38·8 hours per acre and 105 hours per crop acre.

The time spent on working the root crops, that is to say cultivating, sowing, thinning, cleaning, pulling and driving the roots, was 110 hours and 139 hours per acre on farms 1 and 2 respectively. On both farms all the roots were removed from the fields as required for consumption by stock. The average figure for the two farms was 125 hours or 15·6 days of eight hours per acre. As the distance from the fields to the steading was fairly average, this figure of 125 hours per acre would be a reasonably average labour requirement for root crops.

From the figures it is seen that farm 1 required slightly less labour on milking, but when it is taken into consideration that the heifer population would require less time per head than the cows, it would appear that the cattle on both farms are efficiently managed and the labour well organised. The crop figures are more difficult to explain, but it would appear that a more productive organisation of labour is in operation on farm 1 than on farm 2. In the case of farm 2 where the labour staff is required for the cow herd—the keystone to the system of farming practised—it is allowed the remainder of the time to do the other work, and from the appearance of the labour sheets is not required to hurry, hence the work is spread over a longer time. The question now arises whether the best use is being made of this labour; would it be better to increase the productivity of the labour, and if so in what direction should this be attempted?

The specialist in production efficiency would doubtless answer that there is a waste if this labour is not fully employed on productive work, and in many instances this may be correct; but in farming it may be contended that the productive work—say oat growing—which would most likely be done is unremunerative. This may well be correct under certain circumstances, but the writer believes that such a position is only tenable when the already existing balance of enterprises is so affected as to change materially the position of an existing profitable enterprise or enterprises. It may be that to grow extra oats at a very low price, say 12*s*. per quarter, is the most economic procedure open to the farmer. An illustration may bring out the truth of the statement. Under existing conditions a farmer finds on detailed analysis that his labour strength—all absolutely necessary for the main enterprise of the farm—cannot be fully occupied under his system of stocking and cropping, but he finds that with little or no alteration to the stock of the farm another few acres of oats might be grown in place of grass, so that anything obtained for the oats would add to the net profit of the farm as there would be no extra expenses involved. On the other hand, if the sheep or other stock showing a profit has to be materially reduced in order to provide productive work, it is possible that the most economic procedure is to spread what work there is over the period, and make no attempt to intensify the farming practice.

It may be that the labour could be utilised in tending more stock, i.e. increase the dairy herd or ewe flock; this has certain decided drawbacks, especially as agriculture is not in a flourishing financial condition, and in many cases there is a lack of capital to provide the stock. The market for milk is limited, and if the dairy herd were increased the milk produced would tend to be surplus to requirements and could be sold only at a reduced price. This might cause a drop in the net profit of the farm as a whole. The ewe flock increase would not be likely to affect the labour problem to any great extent, as the extra time taken to look after the few more ewes which a farm might be able to carry would be negligible. Poultry and pigs would be in a similar category, although it is hardly likely that the average farm labour would be sufficiently skilled to attend to poultry in an efficient manner.

In conclusion it is suggested that where labour is not fully employed, increased production of crops either for sale or for consumption to replace purchased foods would prove the most efficient method of utilising the labour most profitably.

Displays and Advertising of Scottish National Mark and other Products.

As part of their programme for attracting the attention of the public and of trade buyers to the merits of Scottish National Mark and other agricultural produce, the Department have for some time staged exhibits at various of the leading shows in England and Scotland. By the display of goods of standard quality furnished by different sections of the producing and manufacturing industries, by the sale of small samples and the supply of information to commercial enquirers and members of the public, a considerable amount of effort has been made to interest potential buyers in the merits of Scottish produce.

Particulars are given below of the Exhibitions in which the Department have recently participated, and also of a special publicity service in support of Scottish National Mark Eggs which the Department organised in Glasgow.

International Grocers' Exhibition, London, 20th-26th September 1930.—In the Empire Marketing Board's stand at this exhibition the Department displayed representative selections of Scottish honey, cheese, oat products and oat cakes, and packed ox tongue. Samples were made available for visitors. The business done was highly satisfactory, over 60 firms in England, Northern Ireland, United States of America and Belgium making enquiries with a view to securing supplies of the produce exhibited.

The Imperial Fruit Show, Leicester, 24th October-1st November 1930.—With the co-operation of the Scottish Seed Potato Trade Association, the Department staged an exhibit consisting of nineteen varieties of Scottish seed potatoes. The exhibit attracted a considerable amount of attention, especially from farmers, allotment holders, gardeners and potato merchants; and advice was given regarding the sources of supply, the suitability of certain varieties for different types of soil, and the regulations governing the import of seed potatoes into England.

The Scottish National Fat Stock Show, Edinburgh, 3rd and 4th December 1930.—The Department's exhibit at this Show consisted of the following Scottish National Mark Products :—beef, eggs, tomatoes and potatoes. Demonstrations were given in the testing and grading of eggs.

The British Industries Fair, London, 16th-27th February 1931.—This was the first occasion on which the Department held a separate Stand at the British Industries Fair. Their display included Scottish National Mark eggs, ware potatoes and malt products, and also oat products, oatcakes, seed potatoes, cheese and honey. Typical fleeces of wool of various grades were also included in the exhibit. Small samples of various commodities were offered for sale, and attractive advertising material descriptive of the different products was distributed to visitors. It is believed that the exhibit amply fulfilled the purpose for which it was intended, and considerable interest was shown by buyers for home and overseas markets.

Press and other publicity for Scottish National Mark Eggs.—With a view to stimulating the public demand for Scottish National Mark Eggs, the Department organised during March a special publicity service in certain parts of Glasgow. Preliminary notices were inserted in the principal trade papers, and, during the period 9th to 21st March, when supplies of home-produced eggs became more abundant, a prominent advertisement appeared daily in all the evening newspapers and in a section of the suburban press. A brief note was also published in the news columns of the evening newspapers. Attractive display cards were supplied to shopkeepers stocking National Mark Eggs in the selected districts, and a list of these shopkeepers was prepared for issue to enquirers regarding sources of supply. On 9th March a more direct appeal was made to consumers by the issue to some 10,000 householders in Glasgow of a personal letter signed by the Secretary to the Department impressing upon them the qualities of Scottish National Mark Eggs.

THE following article is contributed by Professor R. H. Leitch, of the West of Scotland Agricultural College.

Effect of Fore-milk and of the associated organisms on the character of Cheddar Cheese.

In the production of a clean and high grade milk intended for market purposes, it is a routine practice to reject the fore-milk—by which is implied the first three or four streams from each teat. The reason for this is that the fore-milk is invariably contaminated, the bacterial count in the newly drawn fore-milk varying according to our investigations from 16,000 to 150,000 per c.c. These numbers, while relatively low, quickly increase under suitable temperature conditions, so that when the bulk milk reaches the market the bacterial numbers especially under summer conditions are likely to be high if the fore-milk is not excluded. In effect the inclusion

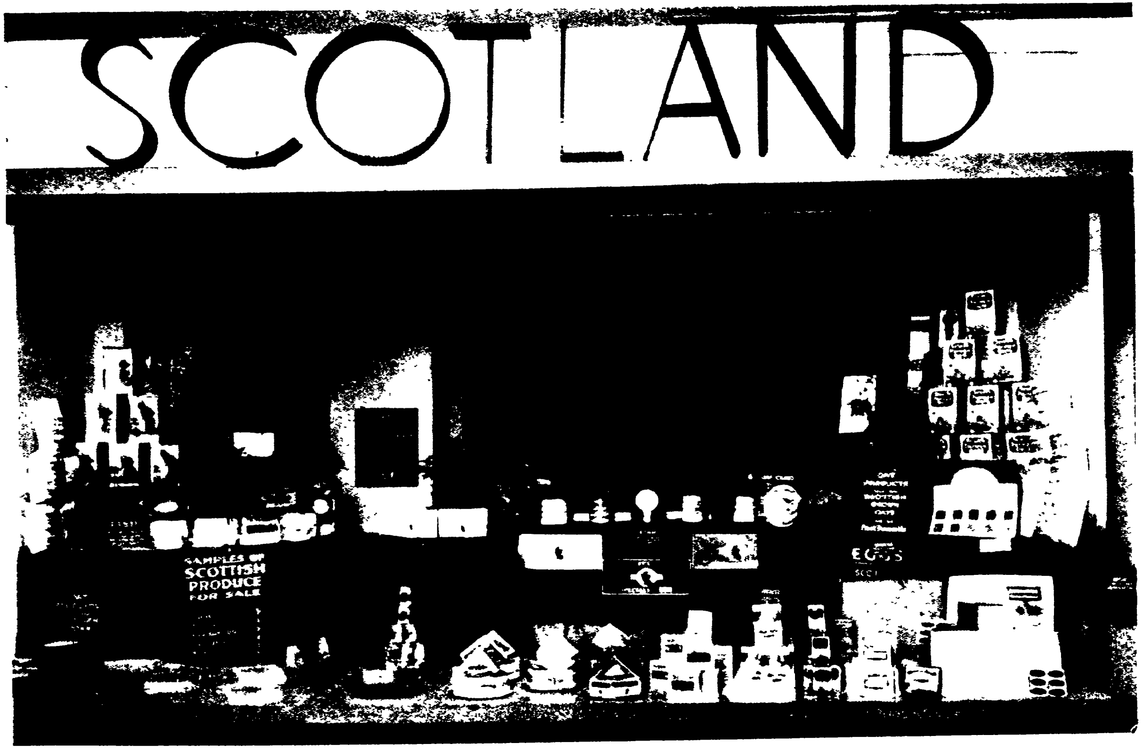

EXHIBIT OF THE DEPARTMENT OF AGRICULTURE FOR SCOTLAND AT THE BRITISH INDUSTRIES FAIR, LONDON.—February, 1931.

Exhibit of the Department of Agriculture for Scotland at the British Industries Fair, London—February, 1931.

of the fore-milk is equivalent to the inoculation of the market milk with organisms of an unfavourable type. Among the organisms which occur commonly in the fore-milk are micrococci, thermophilic organisms which give rise to pin-point colonies, members of the colon group, and occasionally lacto-bacilli, lactic acid bacteria and actinomycetes.

The effect of the fore-milk on the quality of cheddar cheese has not hitherto been determined by exact experiment. Whether the organisms commonly present in the fore-milk exert a controlling influence on the flavour of the cured cheese appears to be unknown; their relation to colour defects has not yet been considered. In our experiments on discoloration in cheddar cheese, it has been clearly established that the causal factor is associated with the primary milk and is of bacterial origin. As the fore-milk is the most highly contaminated portion of the milk taken from the cow, the possibility of the causal factor having its origin here deserves investigation. If cheeses made from a milk supply from which all fore-milk has been excluded do not become discoloured, while those made from milk in which fore-milk is present become bleached during curing, the presumption that the fore-milk is the bearer of the discoloration agent would be strong. With the object of determining these two points—the effect of the fore-milk on the flavour and colour of cheddar cheese—a series of experimental cheeses, 24 in number, was made in the Dairy Research Department of the West of Scotland Agricultural College in June and July 1928.

In carrying out this experiment, about one quart of the first drawn milk was taken from the individual teats of each cow. This quantity of course represents much more than the first three or four streams from each teat, but will be alluded to as the " fore-milk " in this report. The remainder of the milk of each cow (the mid-milk and the strippings) furnished the milk from which the control cheeses were made. The fore-milks from each were collected and added together, but as this did not provide sufficient milk to make an experimental cheese of the desired size, some of the mid-milk was added to make up the necessary volume (22 gallons). The " fore-milk " represented on an average about 50 per cent. of the total quantity used in making each experimental cheese, but the amount varied on occasion from 35 per cent. to 65 per cent. It will be observed that the amount of true fore-milk present in the milk from which these experimental cheeses were made is much greater than is ever likely to occur under practical conditions. The cows which furnished the milk used in the experiment were at pasture daily, and the trials were carried out in mid-summer when conditions for milk production are usually good. It may be argued that the organisms now predominating in the fore-milk will not necessarily be of the same type as those which prevail in the early part of the cheese-making season when the cows are housed indoors, but as discoloration is just as prevalent in summer as in spring made cheeses, and as clean milk production is just as practicable in spring as in summer provided hygienic measures are adopted, the main object of the experiment is not affected by the season when it is carried out.

In order to determine the relative bacterial numbers present in the experimental and in the control milks, a sample of each was taken in the evening, cooled down to 70°F. (the temperature at which the cheese milk is left overnight), and held over for 12 hours. To this was added an equal volume of the morning milk, and the mixed milk plated out two hours later. The average bacterial count of the "fore-milk" mixture was 86,700 per c.c. and of the control milk 77,000 per c.c. On individual occasions the count fell as low as 7,000 per c.c. and rose as high as 260,000 per c.c. in the fore-milk mixture. It should be noted that the sample of evening milk was held over for 12 hours before plating out and under temperature conditions which are calculated to favour bacterial development. This accounts for the relatively high numbers recorded, but these numbers are likely to be in accord with those which would be present in the mixed evening and morning milk if the starter were not added to the evening milk in the morning before all the morning milk is introduced into the vat. The official method of making milk counts was followed. It should also be observed that the official medium does not record all the bacteria present in milk; on account of the absence of a readily fermentable sugar like lactose, lactic acid bacteria if present are not likely to be registered by the "plate numbers." Only on two occasions was *B. coli* found to be present in the "fore-milk" mixture.

Throughout the period of the experiment the cheeses worked normally, the "time of making" running regularly about six to seven hours, an interval which experience shows is productive of the desirable body and texture in the ripe cheese. Starter, a pure culture of *Streptococcus cremoris*, was employed at the rate of 1 lb. to 20 gallons milk. The maximum temperature of scald was 104°F.

The average fat content of the "fore-milk" mixture was 2·62 per cent.; the average of the control milk was 3·72 per cent. The daily variation from the average was small. Special attention is directed to this fact because of the effect which the fat content of the milk has on the texture and body of the cured cheese.

The cheeses were cured at temperatures which varied from 45° to 55°F.

Results of the Experiment.—The cheeses were examined by an expert judge when they were nine months old. It was considered advisable to allow this long period of ripening to elapse before examining the cheeses for two reasons, firstly because the discoloration factor if present would show its effects much more plainly in mature than in young cheeses, and secondly because if the organisms in the fore-milk have any deleterious effects on the flavour, the defective flavour would be more pronounced in cheese of this age.

Relation of Fore-milk to Discoloration.—As regards the effect of the fore-milk in inducing or accelerating discoloration, the evidence of the experiment was almost wholly negative. Only in one cheese did there appear the merest trace of a colour defect, and it appears from the record of this cheese that the bacterial count of the " fore-milk " was relatively low, 14,800 per c.c. No coliform bacilli, according to the presumptive test, were present in the milk, and the reductase fermentation test was good. The flavour of this cheese was satisfactory.

Relation of the Fore-milk to Flavour of the Cheese.—The flavour of the " fore-milk " cheeses was uniformly good, and did not differ materially from that of the control cheeses. The latter cheeses, however, were always more attractive from a market point of view because of their superior body and texture, characteristics which are largely influenced by the fat content of the primary milk.

Distinctive features of this Experiment.—The controlling influence of the fat percentage in the primary milk is clearly reflected on the texture and body of the cured cheese. Because of the higher fat content of the " after-milk," the control cheeses far excelled the experimental cheeses in " quality." Not only so, but the weights of the ripe cheeses in each category were markedly different. From equal weights of milk, the green curd of the " fore-milk " group was on an average 2½ lb. less than that of the control cheese. When the cheeses were cured for nine months, the difference in weight was greatly accentuated. An average difference of 4·8 lb. was recorded, the mean weight of the experimental cheeses being 16·5 lb. and the mean of the control group 21·3 lb.

This loss in weight during curing of the " fore-milk " cheeses is of some importance from an economic point of view. From a commercial standpoint, however, the difference in quality was of much greater moment. The judge estimated that the difference in value between the control and the experimental cheeses was from 1½*d*. to 2*d*. per lb. The experiment showed clearly that skimming of the cheese-milk or the use of a milk low in fat is detrimental to the maker and to the commercial value of the cheese. It may again be observed that the flavour of the ripe cheeses of both groups was equally good.

Summary.—It does not appear from the evidence of this experiment that the fore-milk of pasture fed cows has any marked effect on the flavour or colour of cheddar cheeses which are made with a pure culture starter of lactic acid bacteria. Apparently the organisms introduced by the fore-milk do not in comparison with the bacteria added by the starter raise the bacterial content of the cheese milk to such an extent as to have any marked effect on the flavour or quality of the cured cheese. Nevertheless, on other grounds, the exclusion of the fore-milk is highly desirable.

Notes from Agricultural Colleges.

Craibstone.

Oats, 1930.—A forward step was made this year in the investigations dealing with the standing power of oats after lea with wild white clover. The new variety sent out by the Scottish Society for Research in Plant Breeding as Aa612, and now named "Elder," stood better than any of the other varieties included in the trial. It is, however, very late, and this would limit its use to early districts.

The season was a good one for such a trial, as there was a fairly long spell of warm weather in July which produced rapid growth, and this was followed by heavy rains (fully 1 inch) on the first two days of August. The following varieties were then slightly laid :—Star, Victory, Record, Glasnevin Sonos and Marvellous. During a subsequent dry spell these mainly rose again, but very heavy rain (about 2 inches) from the 17th to 21st again affected the varieties as follows :—

Standing :—Elder, Yielder, M'G.'s Early Pure Line Potato and R30.
Leaning :—Record.
Slightly more :—Glasnevin Sonos.
Lying :—Marvellous; and
Still worse :—Star and Victory.

Still more rain (about 1 inch) at the end of the month sent M'G.'s and R30 slightly down.

The final result when the oats were cut at the beginning of September was as follows :—

Standing	1. Elder.
Very little leaning	2. Yielder,
	3. M'G.'s Early Pure Line Potato,
	4. R30.
Down	5. Record,
	6. Glasnevin Sonos.
Badly down ...	7. Victory,
	8. Marvellous,
	9. Star.

After the crop was cut the weather was very mixed, wet and dry days occurring almost alternately, with the result that both grain and straw were badly damaged; the latter especially lost a considerable amount of weight, as will be seen from the following table, where the yield of grain in several cases is actually heavier than that of straw. The varieties are arranged according to their comparative earliness.

	Per acre.	
	Grain. cwt.	*Straw.* cwt.
1. Yielder	31·6	30·5
2. M'G.'s Early Pure Line Potato ...	28·1	33·1
3. Record	29·2	27·9
4. Star	31·3	27·7
5. R30	24·5	24·8
6. Victory	27·6	27·3
7. Marvellous	30·0	26·8
8. Glasnevin Sonos	25·5	28·4
9. Elder	31·5	32·1

Yielder has all along stood well, but it suffers if dry conditions obtain during the growing period, which prevent the full development of the grain and consequently reduce the yield. In this year's trial there was no long dry spell and the yield was comparatively high. Yielder should be sown only on land where there would be sufficient moisture even in a dry season. One advantage that Yielder has is its earliness. It was cut first and there was almost no loss from shaking, whereas most of the other varieties lost a proportion in this way.

M'G.'s Early Pure Line Potato also has the advantage of being early, and for a Potato type of oat it stood remarkably well. It is shorter in the straw than Castleton Potato, and in other trials where both stood the latter produced a rather larger crop of both grain and straw, but there is no doubt that for those who prefer this type of oat after lea the Pure Line is to be preferred. One disadvantage of this variety was well illustrated this season. The ears are such a solid mass of grain that in a wet harvest they would sprout very readily in the stook.

Record.—A fresh stock of seed of this variety was obtained from the south, and it was undoubtedly earlier and stood comparatively better than the stock used in previous trials.

Star.—When obtained three years ago this variety was said to be earlier and stronger in the straw than Victory. While it has all along been distinctly earlier, it has not been a good standing variety. In fact it has on the whole been fully weaker than Victory.

*R*30.—This is a new selection sent out by Mr. Runciman. It is of the Potato type, but much shorter in the straw and is later in ripening.

Marvellous.—The result obtained with Marvellous is interesting. When first grown here four years ago this variety was considerably earlier than it is now and was one of the best standing varieties. However, it has been gradually growing later and weaker in the straw. We intend to get a fresh sample from England this year to compare with the present stock.

Glasnevin Sonos.—It was thought at one time that this Irish variety, which was formerly known as Banner Tartary IX, would be a suitable variety to grow after wild white clover, but now after five years' trial it cannot be recommended for this district. It is late in ripening and the grain is of a dun colour, which would limit the demand for it.

Part of the field was ploughed early in January, while the remainder was not ploughed until March, a day or two before the seed was sown. Part of each ploughing was also disced beforehand. Victory was sown over all, a few plots being seeded with different quantities of seed. In no case was there any difference, as the whole crop was uniformly laid from side to side of the field.

An interesting result was obtained in another trial where Potato and Victory were sown at weekly intervals beginning on 8th March. In the latest sown plots there was a considerable amount of weeds, chiefly yarr or spurrey, the amount decreasing with the earlier dates of sowing. Evidently spurrey requires a fairly high temperature for germination; thus in the early sown plots the oats were well started before the weeds came through the ground, and the latter never became established. On the late sown plots, on the other hand, the spurrey came through the ground thickly at the same time as the oats, and was evidently able to compete successfully against them.

As has been the case in several former trials, the heaviest yields were obtained from the early sowings and there was a gradual reduction each week of both grain and straw.

Victory Oats.

	Per acre.	
	Grain. cwt.	*Straw.* cwt.
March 8th	23·0	33·5
,, 15th	22·6	32·8
,, 29th	20·3	30·8
April 5th	19·8	29·7
,, 12th	18·2	28·8
,, 19th	14·0	24·5
,, 26th	10·2	22·7

Kilmarnock.

In the south-west of Scotland many cattle feeders have a distinct preference for undecorticated cotton cake in comparison with decorticated cotton cake.

With a view to determining the relative values of these well known feeding stuffs for beef production, a trial was undertaken at the West of Scotland College Farm, Kilmarnock, with 20 cattle. The cattle used were Blue-greys (Shorthorn Galloway crosses), ten of them having been purchased at the spring sales and summered on the farm, and the remainder purchased in the autumn. The ten bullocks purchased in the autumn were bought from a farm from which the College had purchased for many consecutive years, and these cattle, bred and reared on a cold uplying farm, had always been uniform in type and quality and thus specially suitable for experimental work.

The cattle were divided into two groups, five of those summered on the farm and five of those recently purchased comprising each group. In grouping, care was exercised to make the division as even as possible, especially in regard to weight and quality.

Under experiment the cattle were housed in loose boxes of uniform size, fitted with ample trough and hay rack accommodation. The boxes are also fitted with an automatic water supply. Each box houses two cattle. At the commencement of the trial the average liveweight of the bullocks was a trifle under 9½ cwt.

Daily Ration.—The basal ration common to the cattle comprising the two groups was 70 lb. swedes, 10 lb. ryegrass and clover hay, 6 lb. straw, 3 lb. crushed oats, 1½ lb. linseed cake.

In addition, group A were given 1½ lb. decorticated cotton cake and group B 3 lb. Egyptian cotton cake.

To keep pace with the liveweight increase, and at the same time keep the components of the concentrate ration in the same relative proportion, the daily allowance for the cattle in group A was increased at the rate of 2 oz. weekly, while those in group B were given an increase of 2½ oz. On this basis, the ration per bullock in group A increased in eight weeks by 1 lb. (namely, from 6 lb. to 7 lb.), and that for group B in the same interval by 1¼ lb. (namely, from 7½ lb. to 8¾ lb.).

The cattle were weighed fortnightly and their progress recorded. The group liveweights at the beginning of the trial and at the end, as well as the total increases, are summarised below :—

	GROUP A. *Decorticated Cotton Cake.*	GROUP B. *Undecorticated Cotton Cake.*
At commencement of trial ...	94½ cwt.	94¾ cwt.
At end of trial	113⅝ ,,	114 ,,
Increase per group	19⅛ ,,	19¼ ,,

The liveweight gains obtained were highly satisfactory and very regular within the groups. The average weekly increase for the animals in both groups was almost 18 lb., or fully 2½ lb. per bullock per day.

This was all the more satisfactory in view of the fact that at the end of the experiment all the animals were well finished and ready for slaughter, and in consequence smaller weekly increases might have been expected.

It will be observed that in respect of liveweight increase there was practically no difference between the gains made by the cattle receiving decorticated cotton cake and those receiving undecorticated cotton cake, but as twice the amount of the latter was fed the undecorticated cotton cake would appear to be just about half as valuable as decorticated cotton cake for beef production.

As regards the economic aspect, decorticated cotton cake was quoted recently at £8, 5*s*. per ton and Egyptian (undecorticated) cotton cake at £5 per ton. As one ton of the former, fed in conjunction with the other foods comprising the ration, would appear to give much the same result as two tons of the latter, the saving through using the decorticated cotton cake would amount to £1, 15*s*. per ton.

Further, when we consider that extra carriage is incurred in transporting two tons of the undecorticated cotton cake as against one of the decorticated, and that extra labour is involved in handling and nutting the double quantity, the saving through using decorticated cotton cake will be even greater than has been indicated.

The conclusion would appear to be that for cattle feeding decorticated cotton cake is, at current prices, decidedly better value than undecorticated cotton cake.

A somewhat similar result was obtained several years ago in experiments extending over three winters and carried out at the Crichton Royal Farm, Dumfries. (See The West of Scotland Agricultural College Bulletin, No. 67—"*Report on Cattle Feeding Experiments*, by Principal Paterson.")

Poultry Improvement.

UNDER the Department's Poultry Improvement Scheme, the purpose of which is to assist in the promotion of the breeding of reliable stock, a certain number of poultry stations are approved each year for the distribution of eggs and day-old chicks, a bonus being payable to the holders of these stations on all eggs and "day-olds" distributed under the Scheme. Eggs, &c. must be sold at prices not exceeding those prescribed in the Scheme. The stock used in the breeding pens on those stations is carefully selected for breed characteristics and stamina and for indication of high egg yield, and the birds are ringed by an instructress of a College of Agriculture or by an officer of the Department. The selections are made with a special view to their suitability for improving the general stock of the district.

It is a condition of the Scheme that the female breeding stock must have been trap-nested during the pullet stage. Up to 1928 trap-nesting for three winter months only was required, and there was only one rate of bonus for all stations. In 1929, however, with a view to improving the standard still further, the Department decided to pay a larger bonus in the case of stations where the stock was trap-nested for the full year or 48 weeks.

Having regard to the importance to poultry breeders of securing birds from healthy flocks, the Department arranged in 1929 to discriminate between stations where stock had and had not been tested for freedom from bacillary white diarrhœa. This disease of young chicks is the cause of heavy loss to poultry keepers. It is readily transmissible from one chick to another during hatching and rearing, and can also be transmitted from infected parents to their progeny either through the egg or by contaminated egg and chick appliances. Adult birds which are carriers of the bacillus causing the disease can be detected by means of the blood agglutination test. The Department therefore decided to pay a higher rate of bonus to those stations where all the breeding stock had been subjected at the holders' own expense to the blood test by an authority approved by the Department.

Thus there are now four classes of stations under the Scheme :—

Class A 1.—All females have been trap-nested in the pullet year and the individual daily egg records have been approved by the Department.

Class A 2.—All females have been trap-nested for at least three winter months and the individual records have been approved by the Department.

All breeding stock of Classes A1 and A2 must have passed at least one recent blood agglutination test for freedom from bacillary white diarrhœa. Stock is approved under these classifications only on stations where all breeding birds have passed the same test and where all reactors have been removed and all appliances disinfected.

Class B 1.—As for Class A1, except that a blood agglutination test is not required.

Class B 2.—As for Class A2, except that a blood agglutination test is not required.

The rates of bonus payable by the Department are as follows :—

	Eggs.			*Day-old Chicks.*		
	s.	*d.*		*s.*	*d.*	
Class A1 ...	2	6	per dozen.	4	0	per dozen.
Class A2 ...	2	0	,,	3	6	,,
Class B1 ...	1	6	,,	3	0	,,
Class B2 ...	1	0	,,	2	6	,,

In 1931 there are 73 approved stations classified as follows :—

A1	25
A2	25
B1	8
B2	15

In connection with this Scheme and as a further step towards the breeding of reliable stock, the Department, in co-operation with the College of Agriculture, have this year initiated an "Approved Cockerel Scheme," the purpose of which is to enable station-holders and others to obtain good quality male birds for breeding purposes. Arrangements have been made for the selection and marking of approved pedigree hatched cockerels owned by Class A1 and B1 station-holders who are :—

(1) trap-nesting their breeding pens;
(2) using pedigree trays or bags or other means of identification during incubation; and
(3) keeping satisfactory records of the hatchability, rearability, &c. of the eggs and chicks from individual hens.

The cockerels will be selected by the Instructress of the College in September, provided the birds are not less than five months old and are deemed in every way suitable for breeding purposes. To be approved, cockerels must be bred from hens with egg records in their pullet year of not less than 200 first-grade eggs; pedigree hatching records and identification marks for each cockerel must be available. While a test for freedom from bacillary white diarrhœa will not be required, no cockerel which has reacted to this test will be approved.

Cockerels which are approved will be marked with an indelible mark, which will be recorded on a breeder's certificate of pedigree for issue with each bird on sale. This certificate will be endorsed by the Instructress.

Copies of the list of station-holders who have had cockerels approved under this Scheme will be available for distribution in due course.

Developments in the Congested Districts.—In order to improve the standard of the poultry industry in certain parts of the Congested Districts where the establishment of poultry stations as specified above has not yet been found practicable, the Department propose as an experiment to set up a few Second Grade stations under conditions somewhat less onerous than those attaching to the ordinary stations. It is hoped, however, gradually to raise such stations to the full standard required by the Scheme. A reduced bonus will be payable in respect of eggs supplied by Second Grade stations, and the area of distribution will be restricted so far as practicable to the immediate vicinity of the station. An endeavour will be made to establish a few Second Grade stations during 1931-32 for the purpose of distributing eggs in 1932 in districts where there are no ordinary stations under the Scheme.

As an additional means of improving stock in the Congested Districts, the Department have offered this year a limited number of prizes, in the forms of sittings of eggs and day-old chicks, to the best pupils in poultry-keeping classes conducted by Instructresses of the Colleges of Agriculture in those districts. The prizes will be awarded to pupils who have displayed a keen and intelligent interest in the work of their class, and are known to have facilities at home for making use of the prizes. The Department hope to learn, as a result of reports which will be made in due course, that the experiment is fulfilling its purpose.

It is anticipated, however, that the scheme will help to spread a knowledge of modern methods of scientific poultry rearing in isolated parts of the Highlands and Islands.

Reviews.

Mineral Content of Natural Pastures. Sixth Report of the Pastures Committee of the Economic Council.—In July 1925 the Committee of Civil Research appointed a Sub-Committee "to consider and report on the mineral content of natural pastures." This publication is the sixth and latest report of that Sub-Committee, which is now a Committee of the Economic Advisory Council.

Previous reports have indicated the economic importance of the subject both in the home country and in other parts of the Empire. They have dealt in a general way with investigations carried on mainly in Kenya and in Scotland by workers attached to the Rowett Institute and financed by grants from the Empire Marketing Board. These reports have shown that in Kenya deficiencies of minerals in natural pastures do occur and that these deficiencies can be made up to grazing animals, with the result that the animals become less susceptible to disease, that the young grow more rapidly, and that the weight of fleece in sheep is increased.

Later grants from the same source allowed the work to be continued in Kenya and extended at home, co-operation being obtained with workers in Edinburgh, Cambridge and Aberystwyth. The home work is still proceeding, but the field investigations in Kenya are practically completed, and the results are set forth in the present Report as drawn up by Dr. Orr of the Rowett Institute associated with the Director of Agriculture in Kenya, Mr. Alex. Holm.

The following are the main results :—

(a) *Composition of pastures.*—The pastures in all four districts from which samples were taken are markedly deficient—as compared with good pastures—in sodium and to a less extent in chlorine. In one of the districts the pasture, apart from this deficiency in sodium and chlorine, was as rich as good British cultivated pasture. In the other three divisions the pastures were deficient in all mineral nutrients and also in protein. The element in which they were most deficient was phosphorus.

(b) *Effect of treatment by fertilisers.*—The application of different kinds of fertilisers to the pastures in the most deficient area increased the yield of pasture from 25 per cent., where salt only was used, to 400 per cent. where nitrogen and phosphates were used.

(c) *Feeding Experiments.*—In districts where the pastures were deficient in certain minerals the provision of these to the grazing animals was followed by an increase of about 30 per cent. in the yield of dairy cows, about 10 per cent. in the rate of growth of lambs, and about 10 per cent. in the weight of fleece in sheep.

(d) *Prevention of a disease—" Nakuruitis."*—A disease known as " Nakuruitis "—believed to be caused by some deficiency in the pasture—was prevented from developing if the animals were allowed access to a mixture of common salt and iron salt.

Experimental and demonstration work is being continued on the Government Farm at Naivasha, an area of 4,000 acres which has been handed over for a period of three years to be run by the Rowett Institute representatives. The results obtained in the course of the first year have been very encouraging.

The Report is published by H.M. Stationery Office.

Reactors in Tuberculin-Tested (Licensed) Herds. Alex. B. Fowler, B.Sc., and Norman C. Wright, M.A., Ph.D.—This is the second Bulletin issued by the recently established Hannah Dairy Research Institute. It deals with the vexing problem of the recurrence of reactors in tested herds, i.e. the occasional discovery of reactors in a herd after the initial clearing. The authors limited their investigation to licensed tuberculin-tested herds in Scotland, that is herds producing either " Certified " or " Grade A (Tuberculin-tested) " milk. Out of the 110 licensed herds information was obtained from 96, and the investigation was made over a period of six years—1923-29. Over the whole of the period the total number of tests carried out was 28,221; the total number of reactors was 428; and the average percentage of reactors at each six-monthly test was 1·53.

A satisfactory feature of this state of matters is the remoteness of the possibility of any of these herds supplying tubercle-infected milk. Not more than 2 per cent. of reacting cows do actually secrete tubercle bacilli in their milk. The actual proportion of reactors in licensed herds which might be dangerous to the consumer is probably less than three in every 10,000 animals, and it is noted that out of 550 samples of milk from tuberculin-tested herds examined in connection with the Glasgow Hospitals' milk supply not one sample was found to be infected.

An examination of the sources from which reactors in T.T. herds may contract fresh infection was made by investigating the case histories of 462 reactors. The most common sources were infected bought-in stock, contact with other reactors or untested stock, and contaminated premises and pastures. The report points out that less than 10 per cent. of the reactors contracted infection from sources outwith the control of the owner, and proceeds to recommend measures by means of which the various avenues of infection may be closed. These suggest a more frequent use of the test, maintaining the herd exclusively by home-breeding, and where home-breeding is not possible the utmost precaution in introducing bought-in stock. Recommendations are made for constant and unremitting care to prevent the spread of infection on the farm.

The double intra-dermal test is regarded as the most reliable, but it is suggested that better results would be obtained if a uniform technique and a standardised tuberculin were adopted.

International Dairy Congress, Copenhagen, 1931.

AN International Dairy Congress under the auspices of the International Dairy Federation is being held in Copenhagen from 14th to 17th July 1931. The Congress, which is being organised by the Danish Section of the Federation and Organisations of the Danish Dairy Industry in co-operation with the Danish Government, will afford an opportunity for the discussion of matters of importance relating to the scientific, technical and economic aspects of the dairy industry.

Arrangements have been made in connection with the Congress for afternoon excursions and study tours to different fields of activity in and around Copenhagen, e.g. the Copenhagen milk supply establishments, the Royal Veterinary and Agricultural College, the State Research Laboratory and Serum Laboratory, the Royal Technical College, the State Serum Institute, the Hygienic Institute of the University, the State Experimental Dairy, co-operative dairies and agricultural concerns of various types, &c.

Several longer excursions have been arranged to take place on the conclusion of the Congress. These will give delegates and others an opportunity of visiting the most important institutions connected with the Danish dairy industry, and will enable them to obtain an insight into general agricultural conditions in Denmark.

Further information regarding the Congress may be obtained from the Secretary, Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

Agricultural Conditions.

THROUGHOUT the greater part of December the rainfall was heavy in practically all districts, but there was a marked absence of frost or snow. The mild and open weather continued generally throughout the country until about the end of January, when the conditions became changeable, frost and snow alternating with open and wet periods in most districts until the middle of February. During the latter half of February the weather improved somewhat and arrears of ploughing were overtaken in several districts, but in South Ayr the planting of early potatoes was delayed owing to the sodden state of the soil.

The winter sowing of wheat was completed by the end of 1930 in practically every district; in Kincardine, however, the work was delayed owing to the unfavourable condition of the soil. At the beginning of January a good healthy braird was showing on early sown fields in South-West Angus, North-East Fife, the Lothians and Berwick. The open weather during that month favoured the growth of the crop, and in most districts the braird was regular and healthy, but late-sown areas were slow to braird. Despite the severe weather in February the crop generally made satisfactory progress, though growth was checked in many districts, while in Central and South-East Perth the plants were discoloured to some extent by frost. From the estimates furnished by the Department's Crop Reporters it would appear that there will be a further diminution in the area under wheat this year. The reduction in area varies from 5 per cent. in most districts to about 25 per cent. in Renfrew.

The reports on potato stocks furnished at the end of January were, on the whole, disappointing; disease and rot are reported in many areas, second-early varieties being especially affected. In Roxburgh, Selkirk, Sutherland and several western and south-western districts, however, the tubers are keeping well, but a certain amount of sprouting is reported from South Ayr.

Sheep stocks have thriven well in most districts throughout the winter, especially on low ground, though hand feeding was necessary in many areas during February. In Angus, Central Perth, Berwick and Sutherland hill ewes were adversely affected by the weather. At the end of February lambing prospects were generally reported to be satisfactory; in Stirling, however, the ewes were reported to be thinner than usual and not likely to milk so well. In the earlier districts where lambing had been in progress since late January the fall of lambs was that of a normal season, and none of the reports showed any abnormal death-rate. There has been a scarcity of food for milking ewes in South-East Perth, while in Berwick the lambs were affected by the stormy wet weather of February.

The general condition of the root crops was reported in January as being below the normal and in some districts the roots had not bulked well. By the end of February turnips were becoming scarce in many districts and the stocks were of an inferior quality; other fodder supplies were also becoming exhausted in some areas. In Berwick many lambing ewes were being fed on hay in place of turnips. In several western and south-western districts, however, turnips have kept well, and in these areas there is little shortage of keep. Sugar-beet pulp has been used as a supplement to the rations in some districts where turnips are scarce.

The supply of labour has been ample for requirements in practically every district during the winter months, except in South-East Perth and Ross and Cromarty, where casual workers have been somewhat scarce. In Renfrew the supply of female dairy workers has been short of requirements throughout the winter.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Hybrid Vigour in Oats. *By F. A. Koffmann and G. E. Wiebe, Jour. Amer. Soc. Agron, Vol.* 22, *No.* 10.—Hybrid vigour was studied in the F1 and in a few crosses in the F2. In studying hybrid vigour in the F1 the characters considered were plant height, panicle length, number of culms, total plant weight, straw weight, grain weight and date of heading. Plant height was often increased to some extent by hybridisation, panicle length was increased in some, but not in all hybrids. The increase usually was not great. The number of tillers often was decreased in the hybrid plant. Grain yield was often increased in the F1 hybrid plant. The increase on an average was nearly 20 per cent. In the F2 generation of some crosses a marked increase in yield was noted. Apparently hybrid kernels were heavier and produced more vigorous plants than kernels from plants of the parental strain.

Physiological Studies on the form of Potassium Manuring of Chlorine-sensitive Plants. *By Dr. A. Becker, Angewandte Botanik, Band XII, Heft* 2, *March-April* 1930.—From the observations and experimental results quoted it is shown that sulphate of potash is preferred to potassium chloride :—

(1) If the soil treated is deficient in lime and the manure depletes the soil of lime.

(2) If greater abundance of potash is given shortly before sowing to prevent delay in germination.

(3) In the manuring of plants sensitive to chlorine, particularly potatoes and sugar beet, since sulphate of potash increases the production of carbohydrates.

(4) In tobacco culture, since the quality and keeping powers of the tobacco are lowered by manuring with potassium chloride.

(5) In fruit and vine cultures, since sulphate raises the sugar content, improves the aroma and hastens maturity. With tropical cultures such as pineapples and oranges an important point is that the keeping quality is raised by sulphate of potash.

(6) In garden cultures, since the flowering is hastened by sulphate.

Some of the Factors influencing Yield and Quality of Red-Clover Seeds. *By R. D. Williams, M.Sc., Welsh Plant-Breeding Station, (Bulletin) Series H,* No. 11, *Seasons* 1921-1929.—The following are some of the results obtained by the writer :—

Owing to the wide range in the time of flowering of the different plants within each variety and of the various heads within the individual plants, it has been shown that red clover seed crops ripen very unevenly, some of the heads being fully ripe before others are in flower.

Some varieties and nationalities were found to have consistently heavier seeds than others. Chilian and New Zealand had the heaviest and wild red and Cornish marl the lightest seeds. There was but very little difference in regard to seed weights between English broad red, English late, Vale of Clwyd, Czechoslovakian, American medium and American Mammoth. Canadian, Italian and Montgomery were, however, appreciably lighter in weight. The seed weights showed a very marked seasonal variation, and even during the same season different samples of the same varieties often exhibited very pronounced differences in this respect.

The weight of the seeds of individual plants within a variety was found to be extremely variable.

In the case of seeds of good quality there seemed to be no definite connection between colour and weight. Brown seeds were, however, appreciably lighter in weight than both purple and yellow seeds.

Individual plants vary within wide limits in respect to the proportion of hard seeds produced. Most of the hard seeds germinated quite readily after they had been rubbed with sandpaper.

There was no correlation between size of the seeds, as indicated by weight, and the germination energy.

SOILS.

Investigations into the Intensive System of Grassland Management: I. The Chemical Composition of Intensively Treated Pasture. *A. W. Greenhill, Journ. Agric. Science, XX*, Part 4, October 1930, 573-586.—The investigations reported form part of a scheme of research being conducted at the Agricultural Research Station of Imperial Chemical Industries, Limited, at Jealott's Hill, Bracknell, Berks., where various aspects of the intensive system are being studied.

The system was developed in Germany during the war by Dr. Warmbold at Hohenheim and introduced into this country in 1926, and consists in the production throughout the grazing season of a continuous supply of young herbage, secured by the rotational grazing of the pasture, which receives adequate dressings of minerals, together with successive and rotational dressings of nitrogenous manure over the late winter, spring and summer months.

As the system is a complete departure from usual practice, the effect of the treatment on the chemical composition of the herbage was not known at the time of its introduction: in fact practically no exact data on the nutritive value of young grass were available. The results presented in this paper are from investigations carried out at three centres from 1926 to 1929 on pasture intensively manured and rotationally grazed at a stage of growth which ranges usually between three and five weeks. Representative samples of the herbage were taken throughout the season.

The main results, briefly stated, are:—the dry matter of the pasture as grazed under the system is a concentrated feeding stuff, rich in protein and comparatively low in fibre; the actual composition is subject to seasonal and yearly variation; seasonal variations consisted in a decrease in protein and a corresponding increase in fibre during mid-season, with a recovery in both respects later. The ether-extract and nitrogen-free extractives also showed definite seasonal variations, the nature of which differed with centre and season. Yearly variations were shown mainly in protein, ether-extract and nitrogen-free extractives. In 1929, an abnormally dry season, protein and ether-extract were diminished in amount compared with the very wet season in 1927, the nitrogen-free extractives being increased. Average fibre content was only slightly higher in the dry than in the wet season.

During the grazing season drought or the early summer flush period produced some reduction in protein content and an increase in fibre content, with a recovery following the cessation of the drought or after the flush period respectively. The variations noted are a reflection of the productivity and habit of growth of the herbage. An abundant growth of young leafy herbage had a higher nutritive value, weight per weight of dry matter, than the more stemmy growth which is liable to be produced in early summer or under drought conditions. The protein content of the dry matter of herbage from pasture intensively manured, including nitrogenous fertilisers, was higher than that from pasture not so treated. Thus the higher milk-producing power of the former pasture may be ascribed in part to improved composition of the herbage, as well as to a higher yield of herbage.

The higher protein content of intensive pasture raises an important practical point—that of supplementary feeding. It has been shown that the digestibilities of the constituents of young grass are very high, and that in view of its high content of digestible protein, such grass is, by itself, an unbalanced food for most classes of stock, especially in the early and late months of the season. Cattle on intensive pastures should therefore be controlled in the quantity of herbage consumed, and a part of their supplementary feed be given in the form of a food rich in carbohydrates. In the early and late months of the season when the nutritive value of the herbage is highest the question of supplementary feeding is of greatest importance. At these times the proportion of indigestible fibre in the herbage is very low, and it is advisable to see that the stock obtain sufficient roughage in their diet by including in their supplementary ration some fibrous food.

Papers dealing with the mineral composition of the herbage and the productivity data are in preparation.

DAIRYING.

Bacteriological Studies in Milk. *M. C. Dupont, Le Lait*, 11, (101), 29. —In spite of care and attention on the part of the producer, milk intended for the market sometimes contains high bacterial numbers. The author examined a case of this kind, and found that the real cause of the high bacterial count which had been reported by the sanitary authorities was not lack of care or cleanliness in production, but the initially infected milk of individual cows in the herd. Out of 30 cows whose milk was examined, two were found whose newly drawn milk contained 220,000 and 150,000 bacteria per cc. respectively. These cows appeared to be healthy, and there was no clinical evidence of udder disease.

Clotted Cream. *W. B. V. Tresidder, N.D.D., Seale-Hayne Agric. Coll. Pamphlet* 35.—In this important bulletin the author, who is a qualified dairy expert, discusses the different methods which are employed in the preparation of Clotted (Devonshire) Cream, indicates the most appropriate technique, and describes the characteristics of a good sample of the prepared cream. A useful section deals with the faults of Clotted Cream and the remedies.

ANIMAL BREEDING.

Cattle.

A Study of the Accuracy of Measurements of Dairy Cattle. *By Jay L. Lush and O. C. Copeland.* 1930. *Jour. Agric. Res., Vol.* 41, *No.* 1, *pp.* 37-49.— All scientific work is based on measurement and weighing. It is essential that we should know the percentage of error that occurs as regards any particular measurement. In this paper 25 different measurements were each taken eleven times on nine cows and ten yearling heifers from the Jersey herd of the Texas Agricultural Experiment Station. Among the measurements were the following :—thickness of skin, fold, cannon circumference, width at eyes, length of pelvis, depth of chest, paunch girth, and dewlap area. In only a few measurements was the standard error of measuring more than 2 per cent., and in about one-third of the measurements it was less than 1 per cent. The errors of measuring were of about the same magnitude as the errors of weighing.

Economic Factors of Abortion in Cattle. *By Lyman H. Rich.* 1931. *Cornell Veterinarian, Vol.* 21, *No.* 1, *pp.* 15-24.—The data upon which this study is based are the production of breeding records of the University of Minnesota. 78 per cent. of the aborting cows aborted only once and only 8 per cent. aborted three or more times. Of those which aborted, 65 per cent. occurred in the first pregnancy. The greater number of abortions occurred during the seventh and eighth months of gestation. The month of gestation at which abortion occurred had a decided effect upon milk and fat production; there was a gradual increase with the age of the fetus at time of abortion. From the records of 28 heifers from the same sire, 14 of which aborted during first pregnancy, with an equal number calving normally, it is shown that a lowered production of 16·5 per cent. in milk and 10·3 per cent. in butter fat is due to abortion. The total loss from abortion in the University herd over a period of 21 years is estimated at £2,500. This does not include losses from cows giving birth to dead calves over 260 days gestation period, or reacting cows not aborting.

It is estimated that in an average commercial herd where abortion occurs in 13 per cent. of cases there is an annual loss of about £150 per hundred cows, while in a typical pure bred herd the annual loss would be about three times as much.

Bovine Quadruplets. *By F. B. Hutt.* 1930. *Jour. Hered., Vol.* 21, *No.* 8, *pp.* 339-348.—" Aagie Segis Calamity " gave birth to four calves in July 1925. She was seven years old at the time and had previously had one pair of twins and two single calves. Of the quadruplets one pair were identical twins, both heifers, the third calf was a bull and the fourth a free-martin. The two heifers proved to be sterile and so were probably also free-martins, but less affected than their sister. The bull was normally fertile.

Identical twinning in cattle is extremely rare.

The Average Ages of Cows and Bulls in Six Breeds of Cattle. *By A. D. Buchanan Smith and O. J. Robison.* 1931. *Jour. of Agr. Sci., Vol.* 21, *Part* 1, *pp.* 136-149.—From the herd book records of six leading breeds of cattle in Great Britain (Shorthorn, Aberdeen-Angus, Hereford, Ayrshire, Jersey and British Friesian) the ages of the parents of 2,615 pedigree calves born in 1925 were tabulated. The average age of cows at calving is found to be 5·722 years ± 0·04, with a standard deviation of 2·816. In four dairy breeds the average age is 5·485 years ± 0·05, while for three beef breeds it is 6·022 ± 0·05.

The "Annual replacement percentage" is the number of heifers drafted annually into a herd or breed as first calvers expressed as a percentage of the total number of actively producing cows in the herd or breed. It is in effect the number required annually to make good the losses, and can be calculated from the average age of the cows at calving. This is found to be at least 27 per cent., and the figure agrees substantially with the estimate of other investigators. The need for enquiry into the reasons for such a high replacement figure is stressed. It is pointed out that the ideal annual replacement figure is 10 per cent., but if the existing figure could be reduced by improved methods to only 16·7 per cent. it would result in a saving of £35 per annum in a herd of twenty cows. Attention is also drawn to the fact that, at the present replacement figure, there is little room for the selection on genetic grounds of females drafted into the herd. A lowering of the replacement percentage would, by giving the breeder a better chance to select his female stock, effect an improvement in the quality of pure breds.

The second part of the paper deals with the average age of bulls at the time their progeny are born. For all the breeds studied this is found to be 3·846 years ± 0·03, with a standard deviation of 1·943. For the four dairy breeds it is 3·687 ± 0·03, and for the three beef breeds it is 4·052 ± 0·04. The annual replacement figure for all breeds was found to be 54 per cent. For the dairy breeds it is 60 per cent. and for the beef breeds 49 per cent. The reasons for this are discussed, and emphasis is laid on the fact that the early age at which bulls are disposed of does not permit breeders to employ the progeny test, which is the surest method of stock improvement. In the dairy breeds over 80 per cent. of the bulls are disposed of before their genetic value can be recognised. No significant difference was found in the proportion of the sexes of the calves in relation to the ages of their parents.

Horses.

The Morphology and Inheritance of the Dominant and Recessive Spotting and Wall Eye in the Horse. *By Klemola, V.* 1930. *Ztschr. Zucht. B.*, 20, *pp.* 24-78.—The writer describes a recessive type of spotting which he distinguishes from the recessively inherited white markings so characteristic of the British breeds of draught horse. The description which he gives does not draw a very sharp distinction.

In the cases described by the author, glass eye (wall eye) was always present in a complete form. He states that glass eye may occur in different colours and patterns but that it is regularly associated with the recessive spotting, and that the inheritance of this spotting and of glass eye is independent of the inheritance of white markings. The factor for glass eye is dominant to the factor for recessive spotting and recessive to the factor for self colour. He thus postulates an allellomorphic series. In its incomplete form this character is just manifested in the left eye.

On the Best Method of Testing and Mating Mares. *By Schtschjekin, V.* 1930. *Ztschr. Zucht.*, 18, *pp.* 447-454.—The Russians in their large scale horse breeding establishments have a unique chance to study many points concerning fertility amongst horses, and they do not appear to be slow to take that opportunity.

This paper embodies the results of three years' observations of the Khrenovoye Stud upon over 100 Orlov mares and 60 Percheron mares. The practical conclusions which may be drawn from this extremely interesting paper may be summarised as follows :—

Mating on the second day of œstrus has a marked difference as compared with that of the first day. The mares should be mated at every œstrus cycle during the breeding season. This greatly increases the chances of fertility. Mating on the first day with a repetition on the fifth day gives better results than mating on the first day of "heat," but these results are no better than when a single mating takes place on the second day. Beyond a few exceptional cases it is sufficient if a mare be mated on the second day of œstrus. (This does not agree with Aitken, who states that ovulation takes place towards the end of the heat period.)

The Spermatozoa Production in Horses: I. The Influence of Frequent Cohabitation on Sperm Production (*Translated Title*). *By W. Polowzow. Pflüger's Physiol.*, 218 (1927), *No.* 3-4, *pp.* 374-385.—Studies of the quantity and quality of spermatozoa produced by four stallions with varying intervals between service indicated that the rest period between service for normal spermatozoa production was 48 hours. Daily mating caused an increase in the percentage of immature sperms. The percentage of immature sperms increased as the daily use of the stallion continued. When there were long intervals between mating, the sperm collected in the epididymis degenerated and many were non-viable. Sexual stimulation did not appear to influence sperm production, and the secretions of the accessory sex glands were introduced independently of the production of spermatozoa.

The Spermatozoa Production in Horses: II. The Influence of Nutrition on Spermatozoa Production *(Translated Title). By W. Polozow and W. D. Nagajew.* 1929. *Ztschr. Tierzücht. u. Züchtungsbiol.*, 13 (1929), *No.* 3, *pp.* 395-414.—A ten-year-old stallion was used for this study, which was continued over four periods in which the ration was modified as follows :—

A basal ration of 15 lb. of oats and 15 lb. of hay was fed throughout, which was supplemented in the second period with 2 lb. of dry peas and 3 lb. of linseed cake. In the third period the basal ration was supplemented with ten hens' eggs and 5 lb. of wheat bran, and in the fourth period with all four of the supplements. The average results per ejaculation for the successive periods were respectively as follows—

The amount of semen, 45, 50, 49 and 50 cc.;
Percentage of living sperm, 54, 51, 62 and 74;
Sperm per cubic mm. of semen, 54,264, 78,890, 157,400, 147,460; and
Total sperm production, 2,885,701,430, 4,141,220,000, 8,085,507,000 and 7,080,405,400.

The results indicate that sperm production during the breeding season may thus be greatly increased by supplementing the ration with suitable proteins and lipoids.

Pigs.

Swine Performance Record: Litter Comparisons. *By C. C. Culbertson, J. M. Evvard, H. H. Kildee and M. D. Nelson. Bull.* 277, *Iowa State Coll.*—Four pigs from each of 46 pure bred and first cross litters were tested on lines similar to those employed in the Danish Litter Testing Stations and the Scottish Pig Testing Stations. These litter groups were put on test at 65 days of age and were fed to the same average final weight of 225 lb. At the commencement of test the average weight of the litters ranged from 35 lb. to 48 lb. The management of all the groups was uniform throughout the test and a record was kept of the total food consumed by each group. The pigs were self-fed and allowed free choice of two rations—(*a*) consisting entirely of yellow maize, and (*b*) a supplemental protein mixture consisting of 60 per cent. meat meal tankage, 15 per cent. linseed oil meal, 10 per cent. cottonseed meal, 12 per cent. alfalfa and ·3 per cent. minerals. It was found that about 80 per cent. of the food consumed consisted of maize and 20 per cent. of the supplemental protein mixture.

The average daily live weight gain per pig between the age of 65 days and the time of slaughter ranged from 1·127 lb. to 1·683 lb., a difference of more than half a pound. The average of all litter groups was 1·381 lb. daily.

The food consumed per pound of live weight gain ranged from 3·2 lb. to 4·2 lb., a difference of approximately 24 per cent. The average food consumption per lb. of live weight of all litters was 3·55 lb.

Two pigs from each litter were slaughtered as soon as possible after the group averaged 225 lb. live weight; the two pigs selected being those which approximated most closely to the final weight limit. Records were taken of the killing percentages, the proportion of the various carcase cuts and edible by-products, and the quality of the carcases. The value of the carcases was estimated on the basis of the value of products per 100 lb. live weight. Returns per 100 lb. live weight ranged from 10·72 dollars to 12·46 dollars.

Some Factors affecting the Sex-Ratio in the Pig. *By H. Krallinger.* 1930. *Zuchtungskunde, Vol.* 5, *pp.* 480-502.—From data numbering over 47,000 animals of two German breeds, the sex ratio was found to be 50·57 ± ·23. From 35,000 animals no seasonal variation in the sex ratio could be observed. Nevertheless there does appear to exist a factor responsible for the production of a definite sex ratio and this may be present in either sex. Small litters with ten or under have a slightly higher number of males than large litters, and it is probable that the sex ratio is slightly higher in first births, but this was not conclusive.

To these facts is appended an interesting discussion on sex ratio and sex determination generally. Apparently a rise in the sex ratio (more males) is associated with a lower fertility, probably owing to difficulty of fertilisation. Attention is drawn to an attempt made in Germany to cure sterility by a special treatment. This treatment produces an astonishingly high proportion of males. The possibility is discussed of the application of similar methods for domestic live stock, but since it would appear impossible to obtain a higher sex ratio without impaired fertility there lies a danger in this method.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in December 1930 and January and February 1931.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(*Compiled from Returns received from the Department's Market Reporters.*)

Description.	DECEMBER.			JANUARY.			FEBRUARY.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	61 0	53 3	43 0	59 7	51 10	43 0	57 9	49 4	42 6
Cross-bred (Shorthorn)	57 8	49 5	36 2	56 3	48 8	35 8	53 11	46 0	35 6
Galloway	56 3	48 0	47 0	51 3	46 11	..	50 5	46 8	...
Ayrshire	54 2	42 0	30 7	53 0	42 0	29 6	52 9	40 9	29 6
Blue Grey	61 11	53 8	...	...	..	...	...	...	...
Highland	54 0	...	...	45 0	...	...	45 0	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	17	9	...	17	9	...	17	9¼	...
	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†SHEEP—	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Cheviot	13	10¾	8¼	12¾	10¾	8½	12½	10½	8½
Half-bred	12¾	11¼	7¾	12½	11¼	7¾	12¼	10½	7¾
Blackface	12¾	11¼	8¼	12½	11¼	8¼	12¼	10¾	8¼
Greyface	13	11¾	8½	12¾	11¾	8½	12½	11½	8½
Down Cross	12¼	10¾	7	12	11	7½	12¼	11	7½
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	11 10	10 9	...	12 1	10 11	...	12 0	10 10	...
Porkers	13 2	12 0	...	13 5	12 2	...	13 2	11 11	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	DECEMBER.			JANUARY.			FEBRUARY.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	15 15	13 4	12 0	15 4	12 19	11 13	15 13	13 1	11 15
Two-year-olds	22 2	17 5	16 0	21 15	17 5	...	21 5	17 13	...
Cross-bred (Shorthorn):									
Yearlings	14 9	11 15	10 10	14 9	11 14	11 0	15 15	11 12	10 15
Two-year-olds	20 12	15 19	15 10	20 10	16 6	...	19 17	15 16	...
Galloway :									
Yearlings	14 4	12 0	...	13 8	...	...	14 18	...	...
Two-year-olds	20 15	16 10	...	...	16 12	...	...	16 10	...
Ayrshire :									
Yearlings	...	...	...	10 3	...	...	11 0	...	...
Two-year-olds	...	...	...	...	...	...	...	...	...
Blue Grey :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds	...	...	...	...	...	...	...	...	...
Highland :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds	...	...	...	...	...	...	...	...	...
Three-year-olds	...	...	...	...	...	...	...	...	...
DAIRY COWS—									
Ayrshire :									
In Milk	31 1	22 8	12 7	29 4	22 0	12 0	28 6	20 19	12 13
Calvers	27 14	21 11	15 12	27 14	21 13	15 8	28 18	21 10	14 15
Shorthorn Cross :									
In Milk	33 11	25 13	...	32 19	24 15	...	32 2	23 13	...
Calvers	31 12	22 13	18 1	31 8	22 3	16 9	29 18	22 5	16 8
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs	...	...	...	...	...	...	37 2	28 6	...
Half-bred Hoggs	34 0	29 0	...	45 10	33 7	...	45 9	36 7	...
Blackface Hoggs	32 3	25 1	18 2	30 11	22 9	19 0	32 0	22 10	17 9
Greyface Hoggs	42 5	34 11	30 0	43 11	36 0	31 0	40 10	34 4	27 9
Down Cross Hoggs	47 6	40 0	...	38 0	...	...	...	...	...
PIGS—									
(6 to 10 weeks old)	35 9	23 9	...	39 9	25 0	...	39 3	26 2	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	December.			January.			February.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF:—		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ...	1	8¾	8⅞	9⅝	8¾	8½	9¾	8¾	8⅜	9⅝
	2	8¼	...	8¼	8	...	9	8⅛	...	8¾
Bull	1	7½	6⅞	6¾	7¼	6¾	6¾	7¼	6⅝	6¾
	2	7	6½	6	6½	...	6	6⅝	...	6
Cow	1	6	5⅞	5¾	6	5⅞	6	6	5¾	6
	2	5¾	...	5⅛	5¼	...	5	5¼	...	5
Irish—										
Bullock or Heifer ...	1	...	...	8⅛	...	...	8½	...	...	8¼
	2	...	...	7⅝	...	...	8	...	...	7¾
Argentine Frozen—										
Hind Quarters ...	1	5⅝	6½	...	5½	6½	...	5	5½	...
	2	5¼	5⅛	...	5⅛	4¾	...	4¾	4	...
Fore ,, ...	1	4½	4¾	...	4⅜	4½	...	4	4	...
	2	4¼	4⅛	..	4¼	4	...	3½	3⅜	...
Argentine Chilled—										
Hind Quarters ...	1	7¼	6⅞	6½	7	6⅞	7¼	6⅜	5⅞	6
	2	6⅞	6¼	6¼	6½	6⅜	6¾	5⅞	5⅛	5½
Fore ,, ...	1	4¾	4¾	4⅝	4¾	4½	4⅜	4⅛	3¾	3⅝
	2	4⅞	4⅛	4¼	4⅜	4¼	3⅞	3⅞	3¼	3⅛
Australian Frozen—										
Hind Quarters ...	1	...	...	5½	...	...	5⅛	...	...	4½
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	4½	...	...	4¼	...	...	3⅝
New Zealand Frozen—										
Hind Quarters ...	1	...	...	4⅞	...	...	4¾	...	...	4¼
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	..	4⅜	...	...	4⅛	...	...	3¼
	2	...	...	...	...	...	...	...	...	...
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	12	11¼	11	12	10¼	11	12	10½	11
	60 lb. & over	11	...	10	11	...	10	11	...	10
,, Cross	under 60 lb.	12	11¼	11	12	10¼	11	12	10½	11
	60 lb. & over	11	...	10	11	...	10	11	...	10
Ewes, Cheviot	1	...	7⅛	7¾	...	6⅝	7⅝	...	6⅞	8
	2	...	...	7¼	...	...	6⅞	...	...	7⅜
,, Blackface ...	1	8	7⅛	7¾	8	6⅝	7⅝	8	6⅞	8
	2	7	...	7¼	7	...	6⅞	7	...	7⅜
,, Cross	1	7	7⅛	7¾	6	6⅝	7⅝	6	6⅞	8
	2	6	...	7¼	...	...	6⅞	5	...	7⅜
Argentine Frozen ...	1	...	...	5½	..	...	5⅜	...	...	4¼
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	5½	4½	...	5¾	4⅜	...	5⅛	3⅞
	2	...	4	4	...	3¾	4	...	3	...
New Zealand ,, ...	1	...	...	5	...	...	4¾	...	...	3⅞
	2	...	...	4½	...	...	4½	...	...	3⅛
LAMB:—										
Home-fed	1	...	...	12	...	...	11¾	...	...	11½
	2	...	...	11	...	...	10¾	...	...	10½
New Zealand Frozen ...	1	...	9	9¼	...	8¾	9¼	...	8⅜	8⅝
	2	...	8	...	...	7⅝	...	...	7⅝	...
Australian ,, ...	1	...	...	7¾	...	...	7⅛	...	...	6⅝
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	7¾	...	...	7⅛	...	...	6⅜
	2	...	...	...	...	...	...	...	...	...

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

Provisions: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	December.	January.	February.
			s. d.	s. d.	s. d.
Aberdeen.	Country … … per doz.	1	2 2	1 9	1 7
		2	2 1	1 8	1 5
	Duck … … ,,	1	2 2	1 9	1 7
		2	1 10	…	…
Glasgow.	Country .. … per doz.	1	2 4	1 11	1 8
		2	1 10	…	1 6
	Irish … … per 120.	1	22 2	17 8	14 10
		2	20 8	16 5	13 3
	,, Duck … … ,,	1	16 6	17 8	14 11
		2	15 0	…	13 8
	,, (Cold stored) … ,,	1	14 4	…	…
		2	13 8	…	…
	,, (Pickled) … ,,	1	13 0	…	…
	American … … ,,	1	12 11	12 1	…
	Argentine … … ,,	1	12 6	…	…
		2	11 11	…	…
	Australian … … ,,	1	16 4	15 0	..
		2	15 4	14 3	…
	Belgian … … ,,	1	17 1	14 3	12 7
	,, (Pickled) … ,,	1	11 3	10 10	10 3
	Chinese (Black) … ,,	1	…	9 10	8 2
	,, (Green) … ,,	1	…	12 6	10 6
	,, (Violet) … ,,	1	…	10 9	9 3
	,, (Duck) … ,,	1	11 1	10 9	…
	Danish … … ,,	1	14 0	13 4	12 9
	,, (Pickled) … ,,	1	12 4	…	…
	Dutch … … ,,	1	15 2	13 5	13 0
	Egyptian … … ,,	1	…	7 6	6 9
	Polish … .. ,,	1	12 1	10 10	9 4
		2	10 4	9 7	7 7
	Swedish … … ,,	1	…	12 4	12 3

Description.	Quality.	December.	January.	February.
		s. d.	s. d.	s. d.
BUTTER:				
Irish Creamery … … per cwt.	1	…	…	…
,, ,, (Unsalted ,,	1	…	…	…
Australian … … ,,	1	115 2	119 3	123 3
Danish … … … ,,	1	137 7	136 0	149 9
,, (Unsalted) … ,,	1	142 5	140 9	154 9
New Zealand … … ,,	1	117 7	122 0	125 6
,, (Unsalted) … ,,	1	…	…	131 6
Siberian … … … ,,	1	116 0	…	…
Swedish … .. … ,,	1	132 7	131 3	140 9
CHEESE:				
Cheddar … … ,,	1	92 0	92 0	92 6
	2	79 5	82 0	82 6
Cheddar Loaf … … ,,	1	96 0	97 0	101 6
Dunlop … … … ,,	1	83 7	85 6	88 6
	2	77 7	80 9	83 0
Canadian… … … ,,	1	84 11	84 2	83 9
New Zealand (Coloured) ,,	1	74 10	68 6	64 0
,, (White) ,,	1	76 5	69 0	63 0
HAMS:				
Irish (Smoked) … … ,,	1	162 0	162 0	154 6
	2	142 10	140 0	136 0
American, Long Cut (Green) ,,	1	98 10	89 0	80 3
,, Short Cut … ,,	1	96 5	92 9	82 9
BACON:				
Ayrshire (Rolled) … ,,	1	120 5	116 6	116 0
Irish (Green) … .. ,,	1	110 10	113 6	118 0
,, (Dried or Smoked) ,,	1	116 5	119 6	124 0
,, (Long Clear) … ,,	1	103 7	103 0	104 0
Wiltshire (Green) … ,,	1	120 0	120 6	127 6
,, (Dried or Smoked) ,,	1	128 0	128 6	135 6
Danish, Sides … … ,,	1	76 7	74 0	71 0
Dutch, Green (Wiltshire Style) ,,	1	67 0	67 9	63 0
American (Long Clear Middles), Green ,,	1	…	…	..
American (Short Clear Backs) ,,	1	95 7	91 6	86 6

FRUIT AND VEGETABLES : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.	Quality.	DECEMBER.	JANUARY.	FEBRUARY.
FRUIT :—				
Apples—		s. d.	s. d.	s. d.
British—				
Cooking ... ... per cwt.	1	...	19 0	...
Imported—				
American ... ... per barrel.*	1	26 7	24 3	26 8
Canadian ... ... per case.†	1	10 11	11 7	12 2
Pears, Californian ... per case.‡	1	13 4§	11 3	14 0
VEGETABLES :—				
Beet ... ... per cwt.	1	4 0	5 9	5 6
Brussels Sprouts ... ,,	1	14 0	15 0	17 6
Cabbage, Coleworts ... per doz.	1	1 3	1 1	1 0
,, Savoy ... ... ,,	1	1 8	1 9	1 8
,, Red ... ... ,,	1	2 10	2 8	2 6
Carrots ... ... per cwt.	1	4 6	4 3	4 3
Cauliflower—				
Broccoli, Cornish ... per doz.	1	4 8	4 8	3 11
French ... ... ,,	1	4 10	4 8	3 11
Celery ... ... per bunch.	1	1 8	2 1	1 5
Cucumber ... ... per doz.	1	24 0	28 6	24 0
Greens ... ... per 120 heads.	1	5 8¶	10 0	10 0
Leeks ... ... per doz. bunches.	1	2 11	3 8	3 3
Lettuce, Cos ... ... per doz.	1	1 8	4 0	4 0
,, Cabbage ... ,,	1	3 1	2 0	4 0
Onions, *Spring* ... ... ,,	1	0 4	0 4	0 4½
,, *Valencia* .. per case.‖	1	7 8	7 9	9 6
,, *Dutch* ... ... per cwt.	1	4 6	4 6	4 8
Parsley ... ... ,,	1	12 0	16 6	14 0
Parsnips ... ... ,,	1	7 0	7 0	7 0
Radishes ... ... per doz. bunches.	1	2 2	4 0	4 0
Rhubarb ... ... per cwt.	1	56 0	31 6	35 0
Spinach ... ... per stone.	1	4 0	4 4	4 0
Tomatoes, *Scottish* ... per lb.	1	0 8½	...	...
,, *Canary* ... ,,	1	0 5¼	0 5	0 5
Turnips ... ... per cwt.	1	2 0	2 2	2 2
Vegetable Marrow ... per doz.	1	4 6	..	...

* 140 lb. (approx.). † 40 lb. (approx.). ‡ 42 lb. (approx.). ‖ 9 stone.
§ 46 lb. (approx.). ¶ Per dozen bunches.

POTATOES : Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	FIRST EARLIES.	SECOND EARLIES.	LATE VARIETIES. RED SOILS. Golden Wonder.	LATE VARIETIES. RED SOILS. Other.	LATE VARIETIES. OTHER SOILS. Golden Wonder.	LATE VARIETIES. OTHER SOILS. Other.
		DECEMBER.					
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Aberdeen, per ton	1	...	...	...	...	...	4 4 6
Dundee ,,	1	...	...	...	...	...	3 16 6
Edinburgh ,,	1	...	3 15 0	8 10 0	8 10 0	...	4 10 0
Glasgow ,,	1	3 15 0	3 11 8	8 0 0	...	6 15 0	4 3 0
		JANUARY.					
Aberdeen ,,	1	...	...	...	...	7 13 9	5 9 5
Dundee ,,	1	...	...	...	...	...	4 9 5
Edinburgh ,,	1	...	6 5 0	...	...	7 0 0	5 6 3
Glasgow ,,	1	...	5 12 6	...	...	7 10 0	5 13 4
		FEBRUARY.					
Aberdeen ,,	1	...	...	...	...	8 6 3	6 2 6
Dundee ,,	1	...	...	...	...	...	4 16 3
Edinburgh ,,	1	...	...	...	...	7 16 3	5 15 0
Glasgow ,,	1	...	5 6 8	...	...	7 12 6	5 13 9

ROOTS, HAY, STRAW AND MOSS LITTER : Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	ROOTS. Carrots.	ROOTS. Yellow Turnips.	ROOTS. Swedes.	HAY. Rye Grass and Clover.	HAY. Timothy.	STRAW. Wheat.	STRAW. Oat.	STRAW. Barley.	MOSS LITTER.
		DECEMBER.								
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
* Aberdeen, per ton	1	...	...	...	76 0	...	...	33 0	...	...
‖ Dundee ... ,,	1	...	12 5	15 7	85 0† 75 0‡	...	60 0	60 0	...	56 0§
¶ Edinburgh ,,	1	...	...	...	90 0† 82 6‡	...	49 0	49 0	45 0	...
‖ Glasgow ,,	1	...	...	...	75 0	80 0	45 0	42 6	...	33 9§§
		JANUARY.								
* Aberdeen ,,	1	...	...	...	81 3	...	...	41 3	...	...
‖ Dundee ... ,,	1	...	12 0	16 6	85 0† 75 0‡	...	65 0	65 0	...	56 0§
¶ Edinburgh ,,	1	...	...	...	90 0† 82 6‡	...	52 6	52 6	46 3	...
‖ Glasgow ,,	1	...	...	...	75 0	80 0	45 0	42 6	...	33 9§§
		FEBRUARY.								
* Aberdeen ,,	1	...	...	...	93 9	...	...	48 2	...	...
‖ Dundee ... ,,	1	...	...	18 0	87 6† 75 0‡	...	...	67 6	...	56 0§
¶ Edinburgh ,,	1	...	...	...	90 0† 82 6‡	...	55 0	55 0	...	...
‖ Glasgow ,,	1	...	...	...	75 0	80 0	45 0	42 6	...	33 5§§

* Loose, ex farm.
† Baled and delivered.
§§ Home (in 1½ cwt. bales).
‖ Baled straw, delivered.
‡ Loose, delivered.
¶ Bunched straw, delivered.
§ Foreign, delivered in town.

FEEDING STUFFS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	DECEMBER.		JANUARY.		FEBRUARY.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	9 8 6	8 19 0	9 6 3	8 15 0	9 2 6	8 17 6
Foreign	8 11 6	7 15 0	8 13 9	7 15 0	8 14 5	7 15 0
Decorticated Cotton Cake	8 6 0	...	8 1 3	...	8 0 0	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	4 5 0	...	4 7 6	...	...
Egyptian (do.)	4 13 9	4 12 0	5 2 6	5 1 3	5 3 9	4 17 6
Palmnut Kernel Cake	7 15 0	...	7 10 0	...	7 10 0	...
Soya Bean Cake ...	9 0 0	8 14 0	9 0 0	8 12 6	9 0 0	8 10 8
Coconut Cake ...	8 5 0	...	8 5 0	...	8 5 0	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	5 1 0	5 6 0	5 1 11	4 15 0	5 4 5	5 1 3
(39-40 per cent. do.)	5 2 6	5 9 2	5 2 6	...	5 2 6	...
Maize Germ Cake—						
Home	8 7 9	...	8 7 6	...	8 1 7	...
Foreign	7 9 0	...	7 0 0	...	6 18 9	...
Maize Germ Cake Meal	5 18 6	...	5 13 9	...	5 10 0	...
Rice Meal	4 9 0	4 6 6	4 9 5	4 5 0	4 5 0	4 5 0
Bean Meal	9 11 6	9 12 0	9 12 6	9 10 0	9 12 6	9 7 6
Barley Meal ...	5 19 6	6 6 8	5 13 9	6 1 8	5 11 11	6 6 8
Fish Meal	19 0 6	18 0 0	18 12 6	18 7 6	18 5 8	18 1 3
Maize Meal—						
Home-Manufactured	6 7 0	6 1 6	6 0 8	5 11 3	5 14 5	5 11 3
South African—						
(Yellow) ...	5 17 6	6 0 0	5 15 11	5 10 0	5 11 7	5 6 3
(White) ...	5 12 6	...	5 16 11	4 17 6	5 10 8	4 17 6
Locust Bean Meal (Fine)	6 8 0	5 14 6	6 10 0	5 12 6	6 10 0	5 13 9
Maize Gluten Feed (Paisley) ...	5 15 3	...	5 15 0	...	5 15 0	...
Maize—Plate ...	5 4 3	5 2 6	4 13 2	4 11 11	4 10 0	4 7 6
Do. African, Flat	5 15 0	...	5 15 0	...	5 15 0	...
Oats—Home ...	9 2 0	6 0 0	8 13 9	6 0 0	8 1 3	5 18 2
Do. Plate ...	4 15 3	5 5 0	4 9 8	4 11 8	4 7 6	4 5 0
Barley Feeding (Home)	7 10 0	6 0 0	6 10 10	5 12 6	4 12 6	5 17 6
Do. Bran ...	6 0 0	..	6 0 0	...	6 0 0	...
Wheat—						
Home	8 19 0	7 3 9	8 6 3	6 3 9	7 7 6	6 0 0
Poultry	6 11 6	7 0 0	6 8 2	6 7 6	5 18 2	...
Imported... ...	6 16 3	...	6 17 6	5 10 0	6 15 0	5 6 0
Middlings (Fine Thirds or Parings)	6 15 9	5 18 0	6 9 8	5 15 0	6 9 5	5 9 5
Sharps (Common Thirds) ...	5 5 9	4 19 6	4 19 8	5 5 0	5 1 3	5 3 9
Bran (Medium) ...	5 16 9	5 13 9	5 15 0	5 11 3	5 16 3	5 12 6
,, (Broad) ...	6 0 3	6 8 9	5 19 8	6 10 0	6 0 11	6 11 3
Malt Culms... ...	3 18 6	3 10 0	4 0 11	3 13 9	4 0 11	3 13 0
Distillery Mixed Grains—Dried	6 0 0	6 9 0	...	6 10 0	...	6 10 0
Brewers' Grains—						
Dried	5 4 6	4 16 0	5 1 3	5 5 0	5 2 6	5 6 8
Distillery Malt Grains—Dried	6 8 2	...	6 10 4	...	6 7 6	...
Crushed Linseed ...	19 16 0	...	18 12 6	21 0 0	18 0 0	...
Locust Beans, Kibbled and Stoned	5 5 0	4 17 6	5 5 0	4 15 8	5 5 0	4 18 2
Beans—China ...	8 17 3	...	8 14 8	8 11 8	8 16 7	8 10 0
Do. English ...	8 8 9	...	8 9 1	...	8 8 2	...
Pease—China (White)	7 14 0	...	7 10 0	...	7 7 6	...
Feeding Treacle ...	6 0 0	6 10 0	6 0 0	6 10 0	6 0 0	6 10 0
Linseed Oil, per gall.	0 3 3	...	0 3 0	...	0 3 6	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	DECEMBER.		JANUARY.		FEBRUARY.	
		Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda * ...	N. 15½	9 15 0	9 15 0	9 18 0	9 18 0	10 0 0	10 0 0
Sulphate of Ammonia (Neutral and Granular) * ...	N. 20·6	9 5 0	9 5 0	9 8 0	9 8 0	9 10 0	9 10 0
Nitrate of Lime ...	N. 15½	...	...	...	...	...	9 15 0
Nitrochalk * ...	N. 15½	9 7 0	9 7 0	9 7 0	9 7 0	9 7 0	9 7 0
Calcium Cyanamide †	N. 20·6	8 11 0	...	8 14 0	...	8 16 0	8 16 0
Superphosphate ...	P.A. 13·7	2 16 3	2 17 6	2 16 3	2 17 6	2 16 3	2 17 6
,, ...	,, 16	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
,, ...	,, 18·3	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Ground Mineral Phosphate ‡	P.A. 26	...	2 10 0	..	2 10 0	...	2 10 0
,, ,, ,, §	,, 26	2 10 0	...	2 10 0	...	2 10 0	...
,, ,, ,, ‡	,, 34	...	3 10 0	...	3 10 0	...	3 10 0
,, ,, ,, §	,, 34	3 10 0	...	3 10 0	...	3 10 0	...
Potassic Mineral Phosphate	P.A. 18 Pot. 9	3 10 0	3 7 6	3 10 0	3 7 6	3 10 0	...
,, ,, ,,	P.A. 21 Pot. 6	3 5 0	...	3 5 0	...	3 5 0	...
Kainit (in bags) ...	Pot. 14	¶3 5 0	3 0 0	3 7 6	3 2 6	‖3 7 6	3 2 6
Potash Salts ...	Pot. 20	¶3 14 9	3 7 6	3 17 6	3 10 0	‖3 17 6	3 10 0
,, ,, ...	Pot. 30	¶4 19 6	4 10 0	5 4 0	4 12 6	‖5 4 0	4 12 6
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	¶9 0 0	...	9 8 6	8 10 0	‖9 8 6	8 10 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	¶11 0 0	...	11 8 6	10 10 0	‖11 8 6	10 10 0
Steamed Bone Flour	N. 0·8/1·0 P.A. 28/30	5 15 0	4 5 0	5 15 0	4 5 0	5 15 0	4 10 0
Bone Meal (Home)	N. 3·29 P.A. 23	7 15 0	...	7 15 0	...	7 10 0	...
,, ,, (Indian)	N. 4 P.A. 20/20·5	8 0 0	...	8 0 0	...	8 0 0	7 5 0
Potassic Slag ...	P.A. 12 Pot. 6	...	3 12 6	...	3 12 6	...	3 12 6
Basic Slag	P.A. 11	...	...	a1 19 0	...	a1 19 0	...
,, ,, ...	,, 12	a2 1 6	...	a2 1 6	..	a2 1 6	...
,, ,, ...	,, 13	a2 4 0	b1 15 0	a2 4 6	b1 15 0	a2 4 6	b1 15 0
,, ,, ...	,, 14	a2 7 0	b1 17 0	a2 7 0	b1 17 0	a2 7 0	b1 17 0
,, ,, ...	,, 15	...	b2 1 0	...	b2 1 0	...	b2 1 0
,, ,, ...	,, 15¾	...	b2 5 0	...	b2 5 0	...	b2 5 0
,, ,, ...	,, 15	...	c2 12 6	...	c2 12 6	..	c2 12 6
,, ,, ...	,, 15¾	...	c2 15 0	...	c2 15 0	...	c2 15 0

Abbreviations :—N. = Nitrogen ; Pot. = Potash ; P.A. = Phosphoric Acid.

* Carriage paid in 6-ton lots. † Carriage paid in 4-ton lots.
‡ Fine grist 80 per cent. fineness through standard 100-mesh sieve.
§ ,, 90 ,, ,, ,, prescribed mesh sieve.
‖ Less 5s. 6d. per ton if lifted at quay.
¶ Less 5s. ,, ,,
a = F.O.R. Glasgow, in 6-ton lots, 80 per cent. citric soluble.
b = Ex-Grangemouth. c = At Leith. 80 per cent. citric soluble.

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THE HANNAH DAIRY RESEARCH INSTITUTE.

NORMAN C. WRIGHT, M.A., Ph.D., Director.

THE dairying industry is one of great and growing importance in Scotland. When the last census of agricultural production was taken, it was shown that the annual value of milk and dairy produce in Scotland had risen from a total of £4,500,000 in 1908 to practically £9,000,000 in 1925. Even when full allowance is made for the general increase in price level over this period, these figures indicate the very considerable growth of the industry during the last twenty years. Moreover it is noteworthy that the value of dairy produce ranks second only to that of live stock in the agricultural produce of the country.

The growth of an industry inevitably brings its concomitant problems, and these in turn necessitate specialised research. The original scheme for the creation of Research Institutes, as formulated by the Development Commissioners in 1911, provided for the establishment of only one Dairy Research Institute in Great Britain, and resulted in the formation and development of the National Institute for Research in Dairying at Reading. However, the rapid growth of the dairy industry in Scotland and the urgent need for extending the scope of dairy research work in Great Britain provided strong arguments for the establishment of an independent Scottish centre. In 1927, therefore, a Joint Committee of Management was constituted by the Secretary of State for Scotland to give effect to the proposed establishment of a Scottish Dairy Research Institute.

Early History.—In deciding the location of the new Institute there appeared to be strong reasons for placing it in the south-west of Scotland. In the first place this is an area in which there was no Research Institute and in which the dairy industry has always been of great importance. In the second place the new Institute would, on account of proximity, be able to work in close co-operation with two important bodies, the University of Glasgow and the West of Scotland Agricultural College. On the one hand it was felt that the establishment of an intimate connection with the University of Glasgow would ensure continuous contact with an institution in which the biological and medical faculties are strongly developed. On the other hand it was considered that the location of the new Institute side by side with the West of Scotland Agricultural College would ensure the maintenance of close touch with those whose work lies mainly in the field of practical farming problems. Intimate and permanent connection with these two bodies was finally assured through the constitution of the Joint Committee of Management, which consists of eight members, three being nominated by the University of Glasgow and three being nominated by the West of Scotland Agricultural College, the remaining two being appointed by the Secretary of State for Scotland. Sir Donald MacAlister, Bt., K.C.B., then principal of the University of Glasgow, was appointed first Chairman of this Committee.

In 1928 the immediate establishment of the Institute was made possible through the generous gift of the Estate of Auchincruive, presented by Mr. John M. Hannah for the joint purposes of agricultural education and research. By the final terms of this gift, the Institute entered into possession of Kirkhill Farm, Auchincruive, near Ayr, a typical dairy farm of about 120 acres. The Development Commissioners, in consideration of Mr. Hannah's gift, made a capital grant of £15,000 to the Institute for the building and equipment of new laboratories and for the extension and stocking of the farm. With the money thus made available the Joint Committee of Management were able to proceed with the building of the new Institute and with the renovation and equipment of the existing farm buildings. This work was carried out under the direction of Mr. A. G. Ingham, F.S.I., A.M.Inst.C.E., Chief Engineer and Surveyor, and staff of the Department of Agriculture for Scotland. The Institute was formally opened on April 25th, 1931, by the Rt. Hon. William Adamson, LL.D., M.P., Secretary of State for Scotland.

The New Buildings.—*The Institute.*—The Institute has been erected on a knoll about 200 yards to the west of the farm buildings, and is constructed of brickwork which has been roughcast in white with "Snowcrete." The dressings round the main entrance and bays are built with reconstructed stone which was prepared locally, while the roof has been covered with red "Broseley" tiles and the windows constructed of steel, coated with zinc for the purposes of preservation. The whole gives a pleasing colour scheme in combination with a light and airy appearance.

Internally special attention has been given to the design with a view to providing a maximum of natural light with a minimum of shadows. The experimental laboratories are accommodated in two wings, which are connected by a corridor off which open the administrative and other offices. The natural slope of the ground allowed accommodation to be provided at a lower level than the principal floor of the building. The caretaker's premises, small animals' room and heating and centrifuge room are situated there, while the reading room, with the library store and office and the general store, are situated on an upper floor, with a main staircase to the reading room, and a service stair in the north-east wing connecting all three floors. The woodwork and flooring are of Columbian pine which has been stained and polished, while the walls have throughout been treated in a light colour of enamel.

The artificial lighting throughout the building is by electricity, while central heating is carried out by means of an electrically-heated low-pressure hot water system. Hot water is also supplied to the laboratories and cloak rooms by means of unit electric heaters. Petrol gas, produced in a special generator, is carried to all working benches, which are also supplied with electric heating and lighting plugs.

There are five experimental laboratories devoted respectively to physiology, biochemistry, nutrition, bacteriology and pathology. At convenient points there are situated the balance room, dark room, media preparation room and chemical store. The laboratories have been well equipped with apparatus for both routine investigation and specialised research.

The Farm.—The farm buildings have been adapted and enlarged from the original buildings of the Farm of Kirkhill. In planning the alterations and extensions, the primary object has been to provide adequate accommodation and facilities for investigation at a minimum of expense—the resulting buildings being, so far as expenditure is concerned, well within the reach of the commercial farmer. Advantage has been taken of the proximity of the main electric cable to instal electric light throughout the buildings, while electricity is also used throughout for power.

The old buildings, which have been renovated and extended, comprise the barn, stable and young cattle byre. The new buildings include the dairy byre, which has been erected on modern principles and which contains examples of various methods of securing and housing the animals. For instance on the one side tubular fittings and yokes have been installed, while on the other side there are concrete stall divisions. Part of the beds have been laid with " Corkphalt," while other parts have been laid with plain concrete and with concrete treated with " Tricosal." Individual drinking bowls have been provided in all cases, but those on the one side are of the "pressure " type, while those on the other side are controlled by gravity feed from a single control tank. Special arrangements have been made to facilitate the accurate rationing of the stock, so that the labour involved in experimental feeding trials is reduced to a minimum. No provision has yet been made for the manufacture of milk products on the premises, but suitable rooms for the cooling of milk and for the sterilisation of utensils have been provided.

A unique feature of the steading is a specially constructed " metabolism " house. This is a two-storey building. On the ground floor one room has been reserved for feeding trials with small farm animals, e.g. goats. On the upper floor there are standings for three cows. These standings are designed to allow for the feeding of accurate quantities of food stuffs, special feed stores being provided on this floor. Immediately below the standings is a collection and observation room in which it is possible to collect and separate by mechanical means the excreta of the animals. Provision is also made for the accurate sampling of collected excreta. By this means it is possible for the staff of the Institute to carry out investigations into the digestibility of various food stuffs and into the fundamental processes of nutrition in milking cows.

The most important live stock on the farm is the dairy herd, which consists of pedigree Ayrshire cattle. All stock are tuberculin tested, the farm being licensed for the production of certified milk. The present stock includes twenty-two heifers (nineteen in milk and three in-calf), four one-year-old heifers, and six heifer calves. There are also five cows which have been acquired for special research work. The stock bull, Auchendrane Sir Minstrel, is eight years old, and is the sire of the highest milk-recorded heifer in Scotland during 1930. There are two one-year-old bulls and one bull calf. Each heifer in the milking herd has been obtained from a different source, so that the initial stock is very representative.

The Institute also possesses a flock of sheep, consisting of forty Greyface ewes, nineteen Blackface ewes, and eight Half-bred ewes, all with lambs at foot. There are three tups, two Suffolk and one Border-Leicester. In addition there are two pairs of horses, one pair being Clydesdale geldings and the other Suffolk geldings. There is also available the nucleus of a small herd of goats, which will be used solely for research purposes.

It will be seen from this brief summary that the Institute is well equipped to carry out both academic research and practical investigations into the many problems which confront the dairy industry. It remains, therefore, to give a brief outline of the main lines along which research and investigations have been planned.

Biological Research.—From the outset it was inevitable that the sphere of work of the Institute should lie largely in the fields of pure and of applied biology. There are many outstanding problems relating to the physiology of lactating animals, the influence of lactation on susceptibility to disease, the relation of bovine disease to human infection, and other aspects of applied biology which are in urgent need of solution. The Institute is in a peculiarly fortunate position to investigate such problems. In the first place it constitutes one unit in the group of Scottish research institutes which are pre-eminently devoted to the intensive study of animal biology. Moreover, while the other institutes deal in the main with individual branches of biology—for instance, nutrition, genetics and animal disease—the Hannah Institute is unique in that its sphere of work includes the study of all such branches of biology, but in relation to one special function, viz. lactation. In this sense its academic work is designed to give a comprehensive view of the influence of both heredity and environment on lactation, while its practical work is largely concerned with the relationship of this function in domesticated animals to the health of the human population. In the second place the Institute has, since its inception, been closely identified with the biological and medical facilities of the University of Glasgow, its first headquarters being situated in the Physiological Institute of the University. In this connection it should be stated that the appointment of Professor E. P. Cathcart, F.R.S., Regius Professor of Physiology in the University, as Interim Director at a somewhat critical period in the early days of the Institute went far towards stimulating the development of research along biological lines. In the third place the Institute is now situated in an intensive milk-producing area in which material for biological investigation is readily obtainable, while its close proximity to a large industrial centre—Glasgow—should provide exceptional opportunity for the study of the relationship of the milk supply to human nutrition and to human disease.

The development of biological research has proceeded along four main lines : the nutrition of ruminants, the physiology of lactation, the breeding of dairy cows, and the study of bovine disease. It should be emphasised that in so far as the work of the Institute deals with such subjects as nutrition, breeding or diseases, it is confined to questions affecting lactation and does not encroach on the province of other Institutes; indeed the aim of the Institute is to work in close co-operation with the other Institutes on all problems of common interest. The following notes indicate the scope of the work, either in progress or immediately contemplated at the Institute.

Nutrition.—The digestive process in ruminants differs fundamentally from that in other domestic animals : a detailed investigation of ruminant digestion in general is therefore a necessary prerequisite to the successful study of practical feeding problems. Moreover the nutrition of dairy cattle demands special study on account of the abnormally large quantities of food constituents which are necessary for the maintenance of high yields of milk. While these two aspects of nutrition provide a wide field for investigation, the work of the Institute has been limited in the meantime to a study of the digestion and assimilation of the nitrogenous constituents of the food, especially in relation to milk production.

Physiology of Lactation.—Closely identified with the problems of the nutrition of dairy cattle are those relating to the physiology of lactation, namely, the means by which the assimilated food constituents are made available for milk production. Investigations on these two subjects are complementary, and the Institute is therefore tackling both aspects of the work simultaneously. Thus, side by side with the study of the nitrogen requirements of dairy cattle, an attempt is being made to elucidate the mechanism of secretion of the nitrogenous constituents of milk. Problems of this character are, in the first instance, being investigated by biochemical means, but there is ample scope for the development of new technique and of new methods of attack.

Breeding of Dairy Cows.—While adequate nutrition forms one factor in the successful maintenance of a dairy herd, it is equally important that the breeder should be in a position to select potentially productive stock. This can only be assured by the applications of principles which are genetically sound and which have in certain instances been applied successfully—if unconsciously—in the past. The scope of work of the Institute would be incomplete if it failed to take into account this important branch of study. As a preliminary, an investigation is in progress which aims at determining the extent of inbreeding hitherto practised in a typical breed of dairy cattle—the Ayrshire breed. It is intended that this should form a basis for future investigations which will be concerned more specifically with the inheritance of productive capacity in milking animals.

The Study of Bovine Disease.—The need for the intensive study of bovine disease is strikingly demonstrated in figures recently secured in an inquiry, initiated by the Institute, into the causes of disposal of cows from dairy herds. These figures showed that, out of nearly 4,000 animals drafted out annually from typical dairy herds, practically 50 per cent. were drafted out on account of disease. This fact in itself provides a strong argument for the intensive study of bovine infections. But it must also be borne in mind that such infections are, in some instances, a direct menace to human health. This applies particularly to bovine tuberculosis, which may readily be communicated to man —and especially to infants and young children—through the consumption of infected milk.

The Institute has already made considerable progress in the study of bovine tuberculosis, as regards both the methods of elimination of the disease from dairy herds and the relation of the disease to the incidence of infected milk. One aspect of this work has earned the support of the Medical Research Council, while another is being investigated in close collaboration with the Department of Health for Scotland. While the study of bovine tuberculosis is likely to occupy the attention of the Institute for some considerable time, it is most desirable that opportunity should be made available for extending the scope of the Institute's work to include other bovine diseases—especially those which may bear a close relationship to the hygiene of the milk supply.

These notes provide some indication of the scope of the biological investigations, either in progress at the Institute or immediately contemplated. There are other important biological studies which should receive attention. For instance, the nutritional value of milk as an item in the human dietary and the influence of an adequate milk diet on susceptibility to disease offer scope not only for scientific but for eminently practical investigation. Again, the study of lactation itself would be incomplete if it included only the determination of the factors controlling high productive capacity: it is equally important to determine the effects of high milk production on the general health and life of the lactating animal. Limitations of staff prevent meantime the exploitation of these and of other subjects.

Technical Research.—While the problems outlined in the preceding pages are primarily concerned with the biological aspects of dairy research—namely, the economic *production* of milk and the elimination of disease from dairy herds—the work of the Institute would be one-sided if it did not also include the study of technical problems involved in the *utilisation* of milk. Other institutions, notably the National Institute for Research in Dairying at Reading and the Dairy Research Department of the West of Scotland Agricultural College, have specialised in problems connected with the manufacture of cheese and butter. At the Hannah Institute immediate attention has been turned towards a different field of inquiry, namely, the problems concerned in the condensing and drying of milk and of its bye-products, separated milk and whey.

The study of these problems has been initiated largely by reason of the acute local need for a means of increasing the value of so-called " manufacturing " milk, i.e. milk which is surplus to the needs of the liquid milk market. The manufacture of butter and cheese frequently entails avoidable loss by reason of the direct wastage of the separated milk and whey which are produced as bye-products in the process of manufacture. And, in additon, the relatively low return from the sale of cheese in this country calls for the exploitation of new methods of disposal of surplus milk.

Work has already been commenced along three lines. First, a detailed examination has been made of all published literature relating to the problems of condensing and drying, with the object of summarising existing knowledge and thus of indicating the most promising lines for future research. Second, with the valuable collaboration of the Royal Technical College, Glasgow, an investigation has been commenced into certain mechanical and physical problems in connection with the drying of milk by the " spray " process—a modern method of drying which is generally recognised to be of outstanding value when applied to labile liquids such as milk. Third, preliminary experiments have been carried out to ascertain the value of manufactured milk-products in allied industries, particularly in the baking industry.

Owing to lack of funds this branch of the Institute's work has been seriously curtailed. This is unfortunate, for delay in the provision of economic methods of disposal means immediate and cumulative losses to the dairy industry, both as regards the uneconomic disposal of surplus milk and the direct wastage of milk bye-products. It is to be hoped that an immediate recognition of this fact will lead to the early provision of increased financial support, so that the Institute may accelerate the development of technical research along the lines detailed above.

These notes provide a brief description of the Institute and a short summary of the main lines of work at present in progress or contemplated. It must be admitted that the completed results are few, this summary containing for the most part a list of projects which have been successfully " launched " but which are not yet far enough advanced to be of direct value to the dairy industry. The Institute has, however, been actively at work for barely two years; prior to the completion of the new buildings, it has been housed in temporary offices and in laboratories in which facilities for its work were far from ideal; its staff is small, and its resources have been severely limited. It is hoped that, with its transfer to permanent headquarters at Kirkhill, Auchincruive, it will not only fulfil its early promise, but progressively increase its sphere of usefulness.

BOTANICAL NOTES IN A CORNFIELD.

Professor F. L. Engledow, M.A.,

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Whether times are good or times are bad those who grow crops must unceasingly strive for a bigger *net* cash return per acre. Net cash return depends largely, of course, on costs of production, and one of the foremost matters now claiming farmers' attention is the outlay that can be afforded for materials and labour in growing the various crops. Apart from this, cash return depends upon the yield of produce per acre and its quality. Of these two, in general, yield is much the more important. Very many factors, some under the farmer's control, some the irresistible forces of nature, influence yield. Certain valuable increases in the yield of cereals, roots and other crops have resulted from the use of fertilisers, the breeding of new varieties, measures against disease, &c.

Now from the scientific point of view the act of securing such an increase is not in itself a finished task. It is necessary to know as precisely as possible not only the extent of the increase or improvement, but in what way it has come about. For without this knowledge it is impossible to apply and exploit the new method fully or to go yet further and improve the improvement. Evidence as to the way in which a new method or treatment or a new variety leads to increase in yield can come only from the plant itself. We have, in short, to try to make the plant tell its own story of increased prosperity. Whether we harvest a ripened crop of wheat or fold a crop of kale we are garnering the produce of several months of growth, and we shall not understand the good or bad yield we get unless we know by suitable measurements and observations the whole story of the growth of the plants from the seed onwards.

This, broadly stated, is why botanical notes or studies of crop development are becoming of great importance in all efforts to increase net cash return per acre by increasing yield per acre. It is the object of the passages which follow to explain in simple

The Hannah Dairy Research Institute

Farm Steading, showing Stackyard and Dairy Byre in background.

Farm Steading, showing Barn, Metabolism House and Stable. The Director's House is in the foreground, and Milk Receiving Rooms on the right.

Biochemical Laboratory, looking towards Balance Room and Dark Room.

Photo by Monnickendam, Ayr.]

Interior of Dairy Byre, showing different types of fittings on either side.

Photo by Monnickendam, Agr.]

terms how such studies of development are made, and their results.

To the practical man work of the kind to be described may seem a long way off from actual farming. It may seem involved and concerned with obscure things. And it is. For the obvious and simple methods of increasing yield have been found out already—mainly by farmers themselves. To make progress in an agricultural system already highly developed we must expect to delve deeply into difficult problems.

Most of this work has so far been done with wheat, and this crop will be used in the account which follows. At first experimental plots were used with seed sown at regular intervals on a carefully made tilth. Up to a point these were very instructive. But with net cash return per acre as the ultimate object of enquiry it became necessary to transfer study to the ordinary crops of the field. The plot experiments showed that the simplest index to the progress and development of a wheat plant is the rate at which it forms first leaves, then tillers or side shoots, and finally ears.

In brief, then, it was the task of the botanist simply to count the numbers of plants in typical fields of wheat, to measure the progress of their growth by counting the tillers, and to make certain other observations later described, carrying out these studies every week from seed time to harvest. It is arduous work on wet, winter days, but serves most effectively to concentrate attention on the hazards and happenings in the life of the plants by which final yield is decided. At the end there results a ponderous mass of figures and observations, but if we review these month by month their meaning is easy to understand.

One field differs greatly from another, but in this account we may conveniently deal with a good, typical piece of wheat which yielded 56 bushels per acre. It was Yeoman wheat sown on October 27th at 2½ bushels per acre with the coulters of the drill 8 inches apart. Counting the seeds on the ground is extremely difficult (though for special purposes it had to be attempted), so we will push our account forward at once to the end of December, by which time all save a small number of very laggard seeds had germinated and sent their shoots up through the surface. At this time a careful count of the plants was made, as it revealed facts which influenced the whole of the future of the crop. The nature and results of this count of seedling plants must be properly understood.

In this field, sown as above described, there would be a total run of about 12½ miles of drill row per acre—as the arithmetically-minded may prove for themselves. And the average number of seeds deposited per one foot length of the row should be about 21. Actually an average of nearly 20 plants per one foot length was found, so the proper seed rate was evidently put on, the germination was good, and very few seedling plants can have died off or been destroyed in the first two months of life.

But averages teach us little. To know that the average size of her children's feet was 5½ would not enable a mother of six to equip them with shoes : the size for every individual child must be known. And similarly for our enquiry we must know exactly how the plants were distributed all along the rows. The method, therefore, was to mark the rows—actually only certain selected rows—into one foot lengths and to count the plants on these lengths.. The result was surprising. In any row, one foot length might have 9 plants, the next 3, the next 18, the next 0, the next 23, and so on in complete irregularity.

The simple business of counting plants—taking a " census " of a field, as it has come to be called—has raised some awkward questions. Why do not the plants stand regularly, foot length by foot length, all the way along the rows? Special experiments of a difficult nature had to be made on this point. The answer they gave was that the seeds themselves were not distributed along the rows with regularity, and that the cause of this lay not to any great extent in roughness of seed-bed, but in certain defects in drill design. If we are to have even sowing, we must have improved drills.

But does this irregularity matter; does it influence net cash return per acre; are we haggling over trifles? The plants themselves must answer this, so let us, omitting intervening observations, push the story on to the end of April. By this time we find an average of 17 plants per foot, so that the total casualties have been only about 15 per cent., i.e. 85 per cent. of the seedling plants have survived to the end of April. In wheat fields generally the survival is usually 65 to 85 per cent. by the end of April, and in normal circumstances these survivors carry on and produce ears at harvest.

We must pause here to note another important happening. It will still be many weeks before the ears are visible, but if now at the end of April we carefully dissect the bigger tillers, we shall find tiny developing ears at their bases. As a fact the first signs of development may thus be discovered just before the end of March. We may infer, therefore, that the circumstances of growth, e.g. fertility of soil, temperature, rainfall, &c., prevailing during the month of April are of great importance in determining the final yield, because it is in that month that the beginnings of ear formation take place.

The irregularities in the stand or distribution of plants in the rows are, of course, just as marked at the end of April as we found them to be at the end of December. But now we can begin to ascertain their effects. In the thin places with, say, 6 plants to the foot length of row, the average number of side tillers per plant may be 8; in dense places with, it may be, 22 plants per foot, the side tillers may average as low as 2 per plant; for the whole field the average number was just over 3½. As we should expect, where the plants stand thinly they have tillered more profusely. But does this extra tillering actually compensate for the fewness of the plants in the thin places? In respect of actual development of tillers there is certainly a strong compensating effect. But we harvest grains, not young green tillers, so let us see what the counts and records tell us of the story of tillering. Tillers (i.e. side shoots) first appear in early January, their number increases steadily right on till the end of May, when the latest formed of them begin to die off. This dying off is a striking thing. Of the abundance of side tillers found on the plants at the end of April no less than 72 per cent. died during May, June and July, only the small proportion of 28 per cent. surviving to form ears at harvest. We come now to another interesting fact. The records show that the tillers which lived on and gave fruitful ears at harvest were those formed before the end of the third week in March. Tillers formed after this time were valueless. Indeed they may have been harmful—though this point is difficult and not yet decided—for they may have depressed the growth of the earlier-formed, surviving, tillers.

Think now of the practice of top dressing winter wheat with a nitrogenous fertiliser in the spring. If this had been applied (for the particular field we are discussing) after the third week in March it would have stimulated not only the fruitful, but also the later formed tillers which are doomed to die. The proper time for applying such a top dressing is thus shown by these experiments to be of great importance. It is being made the subject of special study.

We must pass over the intervening months and look at the final harvest figures. On the average there were nearly 17 plants per foot of row and about 1¼ ears per plant—a figure which most men of experience looking at the crop would have guessed very incorrectly (as, in fact, a number did). The average ear had on it only 27 grains—a poor-looking thing, as the reader will appreciate if he counts the grains in a number of wheat ears. But it was a fine looking crop and the yield was 56 bushels per acre.

At harvest the rows were dealt with a foot length at a time, the number of plants, the number of ears, and the yield of grain from every foot length of row being determined. On foot lengths with few plants there were many ears per plant and the ears were large. This familiar result, however, did not compensate the yield per foot length for deficiency in number of plants. Some simple figures will make this clear. Imagine that we know how many plants there were on all the many foot lengths of row which make up an acre. Now group these foot lengths into five equal sets. We find we can do this by making the following divisions: foot lengths having any number of plants between 0 and 11; next foot lengths having 12, 13, 14 or 15 plants; next those with 16 to 18 plants; then those with 19 to 22 plants; then those with 23 to 38 plants. As the number of foot lengths falling into these groups was the same, we must naturally infer that in effect one-fifth of the whole acre (made up of individual foot lengths) had upon it some number of plants between 0 and 11; another one-fifth of the whole acre had from 12 to 15 plants;

and so on. At first it is a little confusing to think of an acre of wheat split up in this way, but the idea soon becomes familiar. We may, for instance, liken the foot lengths in a row to the houses in a closely-built town street visited by a census official to collect information about the number of people. Now for the figures of yield : in the table below are shown the rates of yield for the different one-fifth parts of an acre, i.e. the rates corresponding to different numbers of plants per foot length.

Number of plants per foot of row.	*Rates of yield in bushels per acre.*
From 0-11	39
From 12-15	51
From 16-18	56
From 19-22	64
From 23-38	73

If we owned a cinema we should expect to charge, say, 6*d*. each for the front seats, 9*d*. for the next, 1*s*. 2*d*. for the next, and so on. But we should do everything possible to fill every seat. In a field sown as here described there are just over 65,000 " seats," i.e. foot lengths of drill row. Some are on very poor patches of soil—the 6*d*. seats; wireworm or a fungus may make other lengths unfavourable—the 9*d*. seats; and so on. But it is clearly worth while to do everything possible to fill all seats. In this field one-fifth of the foot lengths had only 0 to 11 plants each, and on the average they yielded only 39 bushels per acre. In interpreting these figures one must be very cautious for the subject is intricate. Thus, it should not be argued without consideration that if on every foot length we had secured some number between 23 and 38 plants we should have averaged 73 bushels per acre all over the field. But careful consideration suggests that it is safe to say that because of irregularities among the plants in the rows at any rate 20 per cent. of the full potential yield appropriate to the field and the particular season was lost.

Let us finally review the practical lessons these experiments have provided. The most important is the inference that a full, even plant—with a minimum of gaps, thin places and over-thick places in the rows of plants—is a very important factor in net cash return per acre. A perfect plant cannot make up for inherently bad soil, or an unfavourable season, or bad farming; but it is essential, if we are to get the best possible return from such soil as we have, such weather as we get, and such work as we do. What practical steps can be taken to ensure a full, even, plant? The outstanding need is for improved seed drills, but in this we are dependent on the implement makers. Of factors under the farmer's control the drill and the seed are chief. To keep the drill in sound working order is clearly important. Again, seed free from or suitably treated against disease should be sown. Further, it is important to have well screened seed, for bits of straw and other extraneous matter frequently cause chokes in the flow of seed from the drill. With root crops the lesson of the " full plant " is especially important. Experiment has shown that, as with wheat, the seed is badly distributed by the drill. But it is in the subsequent "thinning" or "singling" that loss of potential crop is usually greatest. If a field is ordered to be singled to 9 inches, say, between the plants, a considerably wider interval than this will generally be found. And, as with wheat, the individual plants grow unusually well where the spacing is great, but, after a certain point, this fact does not compensate for loss in number of plants per acre.

It will, perhaps, be conceded that it is well worth while, by careful observation of our corn, our roots and other crops, to try to find out how the plants stand, whether all the " seats " are reasonably well filled, and if not, the cause of deficiency. The rent of a one foot length of row of plants in a typical wheat field (at £2 per acre) is $\frac{1}{160}$ *d*. And whether it carries no plants or 20 it costs its due amount in cultivations and manures.

THE FUTURE OF FARMING.

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IN a recent small volume[1] Mr. C. S. Orwin, Director of the Agricultural Economics Research Institute, Oxford, carries a stage further his analysis of the position of agriculture in Great Britain to-day. His earlier work, in conjunction with Mr. W. R. Peel,[2] led to conclusions favourable to the extension of the national ownership of the land in agricultural use. In the light of a number of studies now appearing in series from the Oxford Institute, dealing with the methods by which pioneers have, in recent times, successfully exploited new systems of farming, he draws certain conclusions as to the future trends of farming in this country and is led to propose means for their more rapid realisation. Proposals emanating from such a source merit close consideration. The earlier policy of land nationalisation is not discussed in the present book, but it is integrally a part of the scheme for the practical achievement of the plans now outlined. We are here concerned only with the place of agriculture in the national life and with the technical problems of agricultural organisation.

The case built up by Mr. Orwin for a reconstructed agriculture in Great Britain is based upon the concept that rural peoples are more stable than are industrial communities. Great Britain has moved earlier and has gone further than any other nation from the simple rural economy of the 17th century. By a phenomenal advance in non-agricultural industry, accompanied by an absolute decline of much smaller dimensions in the number of people occupied in agriculture, the position has been reached that only 7 per cent. of the occupied population of

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[1] *The Future of Farming*, by C. S. Orwin. Oxford University Press, 1930.

[2] *The Tenure of Agricultural Land*, by C. S. Orwin and W. R. Peel. Cambridge University Press, 1925.

Great Britain now find their means of livelihood as tillers of the soil and feeders of live stock. Possibly this may present a somewhat exaggerated picture of the decline in the status of agriculture in the national life. It may be necessary to recall that the modern agriculturist keeps a considerable number of other people busy designing and making his implements, and manufacturing the artificial fertilisers and feeding stuffs which he uses on a scale not hitherto reached. Again he is now, in general, a full-time rather than a part-time agriculturist. But even so, the depletion of the country side is involved.

It may be well to pause to consider the implications of this new balance in our national life. Its primary cause is the development of non-agricultural industry rather than the decline of agriculture. Industrial strength is the *sine qua non* of a large population; it is the main source of our national wealth; it is the foundation upon which our financial supremacy has been built up; upon it rested the weight of the credit of the Allies during the world war. It may not be unnatural, during the blast of depression which has struck the world after the wastage of war and the dislocation of the social, political and economic life of Europe, but is it longsighted or deeply grounded, to lay at the door of those who fostered the growth of industry the charge of building in Great Britain an inverted pyramid, an " unstable pegtop," a nation " parasitic " upon the rest of the world for its food supplies? It is of course true that agriculture is a basic industry in that it, and to a smaller extent fishing, are the sources of human sustenance. But one of the marks of human progress has been the ever diminishing proportion of human energy devoted to food production, and the ever increasing proportion devoted to the manufacture or supply of other goods and services. All nations seek economic amelioration through industrial development. Everywhere the rewards of agriculture are lower than those of industry, and most of the nations of Western Europe, and the people of the United States of America too, have taken long strides towards a reconstituted national life in which agriculture is proportionally less important. It is this fact of the higher economic efficiency of work released from the tyranny of nature, as well as a revived nationalism, that underlies the recrudescence of protective tariffs amongst the reconstructed nations of Europe since the peace, in aid of nascent or of potential industry. If it be right that all this makes for instability, then not only Great Britain but all the world is heading for collapse. Those who take this view may admit, with Mr. Orwin, that the higher levels of rural population and of agricultural production maintained on the Continent of Europe are based upon lower standards of living and on more family and child labour in manual processes than this country has found it necessary to tolerate; it may be granted further that in Great Britain the great industrial developments have raised the earning power of labour for industrialists and agriculturists alike. Even so, the Continental view is upheld that the peasant is a better base upon which to carry the national life than the artisan.

This apparent contradiction rests upon two theses. The first is that all civilisations that have lost their rural bias have ultimately declined, and that this is inevitable in the nature of things. The second is really the first in a modern dress, namely, that Great Britain is losing her export markets, that the world no longer needs in the same measure her coal and her manufactures, that the national " pegtop " is slowing up and is in danger of collapse, and that a return to agriculture is the surest way to regain stability.

Each of these two theses might well be the subject of much profound discussion, in which thinkers in all realms of research as well as the plain and practical man are entitled to speak. The biologist, without giving his unqualified support to the alleged stability of rural peoples, might argue that the mechanism of manufacture and of exchange has outgrown the capacity of mere men and women to control it. Defects in the working of monetary systems and the present dislocation of the world's industry and employment seem to lend colour to this view. The psychologist may demand a holiday from invention in order that men and women may adjust themselves to their present environment, which is changing more rapidly than can human nature and human habit : the pace, he says, has been too hot. The philosopher may dispute the essential worth of material prosperity at the expense of a more deliberate, if less leisured, life in more natural surroundings. The historian may point to the dispersion of the mercantile Jews, the disappearance of commercial Phœnicia and Carthage, the fall of militant Rome, the bankruptcy and decline of Greece, the ephemeral character of the wealth of the city states of the Levant, the rise and relative decline of the Dutch, and contrast all these with the long continued rural civilisations of China and of India. But all these things are apt to leave the economist and practical people engaged in the search for a livelihood a little cold. The population of France is declining despite its rural bias; a stationary population in the United States within a few decades is indicated by the course of the vital statistics. And where are to be found precedents for the decline of a people due to excessive development of their powers in the production of wealth? Decline may follow over-spending or dissipation of material resources; traders and intermediaries may be ousted by stronger rivals; but when or where has any people, inventive, energetic and thrifty, fallen into decay as a result of producing in too great volume or too diversified form the goods and services required for a comfortable and cultured existence? Past civilisations, ancient or medieval, offer no parallels to a modern industrial state.

The second thesis seems to invite the belief that a new world has arisen in which nations will no longer find it to their advantage to exchange commodities as freely as before, and that they will insist upon a greater self-sufficiency even at the expense of material comfort and leisure. As a result Britain, unable to sell her manufactures, is to settle down to growing more of her own food. Now it is of little use to ignore the force of the revived economic nationalism of post-war days, or to deny that this, and the world's economic dislocation, may impose the necessity for tightening our own belts and cutting costs in order to keep the machinery of industry running. But surely it is equally unsafe to assume that the present difficulties under which Great Britain is labouring might have been avoided by a heavier rural bias, or that agriculture is to find a new lease of life and offer adequate rewards to a larger proportion of the population as a result of any readjustments that may be made. Any such claim for agriculture may lead only to disappointment and disillusionment. For such a view of the present situation seems to assume its permanence, and to ignore the more potent causes making for post-war maladjustment. Not only have the active personnel and the accumulated wealth of the belligerent nations been seriously depleted, their trade and finances in some measure unhinged by enlarged international debts and reparations payments, but currency readjustments have brought about an unequal and discontinuous, but nevertheless general and serious, fall in prices. The effects of this fall have been most severe upon debtors, whether nations or individuals, in that their debts must be repaid in money that is now worth more in goods and services than before; exporting nations like Great Britain are especially prejudiced because the fall in certain important costs of production, especially labour costs, tends to lag behind the fall in price of the finished goods. As regards agriculture, of which the home output is less than half of the total supply, any increased purchasing power in the hands of the wage-earners, due to the higher ratio of wages to prices, does not mean any considerable extension of the demand for home-produced food. It may be admitted that during the temporary suspension of international trade as during the war, or its dislocation as in the immediate post-war period, nations with the greater agricultural bias may be the more self-contained and may suffer less as a result; peasant farming will, however, usually be characteristic in such cases. But in the face of the potent and well-recognised causes of the current national and agricultural depression, causes which in the nature of things are temporary, and of which the common sufferings and interests of all the nations of the world will compel the rectification at no distant period, it seems unnecessary, and perhaps, too, somewhat hazardous to our national morale, to decry our industrial development as a mistake, our highly developed but limited agriculture as degenerate.

To insist on the paramount importance of non-agricultural industry is not of course to deny the importance of agriculture in the economic and social life of the nation. So long as there are broad acres to be tilled and human stomachs to be fed, so long as there is land hunger on the part of folk whose roots are deeply set in the soil, and whose instincts and affections draw them irresistibly to hill or glen, agriculture is and must remain of vital significance in the national life. Any claim agriculture as an industry may have for special consideration must surely be grounded rather upon the aspirations of a section of the community to live the life they prefer and to live it as fully as possible than upon any presumed superior importance of agriculture over other industry in the national life. Superiority must be either economic or something which matters more. To-day, as Mr. Orwin points out, the claim that rural life produces healthier human stock than urban life cannot be justified. Even our military advisers regard agricultural self-sufficiency as out of the question. On the other hand, it is unfortunately true that on the average the productive activities of agriculturists add less wealth to the common stock per person engaged than do the activities of those engaged in any other industry of importance; and this seems to result from the fact that there are still too many people engaged in the output of agricultural commodities in the world at large, having regard to the quantity of produce that can be absorbed under present circumstances of world demand. In our own country agriculturists in search of higher incomes have reduced their numbers so as to bring their rewards into closer conformity with those obtainable in other spheres of activity. On the Continent of Europe, on the other hand, where the agricultural population has been maintained deliberately at a higher proportional level, rural rewards nowhere have attained to British standards.

Mr. Orwin, in fact, seems to find himself upon the horns of a dilemma. While regarding the situation at which agriculture has arrived in the national life as fundamentally unsound, he recognises that this has been consistent with the development of a numerically greater and more wealthy people than could otherwise have been maintained, and that major change in the balance of the national life is now impossible. This leads him, while adopting the Continental viewpoint, to reject the diffused settlement of small holders of the Continental peasant type as being unsuited to the English environment, and to seek, within agriculture itself, other forms of organisation by means of which the processes of decay may be arrested. As temporary expedients, the proposal of the Agricultural Tribunal for a subsidy on wheat-growing is revived, and support is given to an embargo on imported potatoes in the interests of greater stability of price. But, taking a longer view, the diagnosis of the agricultural malady results in proposals for a major surgical operation upon the agricultural corpus, which is no less than the replacement of rotation farming on farms of moderate size by specialised production on a large scale. So serious and fundamental is this proposed operation that it is of importance to follow the steps in the diagnosis, and to test its soundness point by point. The diagnosis proceeds as follows :—Firstly, that it is the corn grower who feels most keenly the impact of overseas competition and, on the assumption that land in crops provides employment for the maximum number of people, its area should be maintained. Secondly, that in any case the limits to the laying down of land to grass have probably been reached, leaving the problem of the lighter drier lands of the eastern counties of England still unsolved. Thirdly, that the possibilities in the maintenance of fertility by the use of artificial fertilisers, opened up by the discoveries of the agricultural chemists, have not been sufficiently exploited. Fourthly, that the mixed or diversified systems of farming prevalent in this country place producers at a disadvantage in competition with more specialised forms of production overseas; and fifthly, that success has been achieved in specialised corn growing with the use of artificials in England over a period of years, though such success has been threatened in recent times by the high cost of labour relative to the prices of grain.

From this diagnosis arises the conclusion that the twin stimulants for revivifying if not for promoting the growth of agriculture are specialisation in production, with a view to extending to farming the benefits of large scale enterprise, and the internal combustion engine as an alternative and cheaper source of power. Room is allowed for some development of family farms, e.g. in stock-rearing, and for the small capitalised farmer, e.g., in dairy farming, but these are concessions to land hunger and not to any greater efficiency due to smallness of scale. A national survey would be necessary to provide a guiding chart in delimiting the areas for specialised production in various forms. As a necessary incident in the reallocation of the agricultural lands, the State might be called upon to assume the ownership of the land and responsibility for finance, on lines with which the reader of Mr. Orwin's earlier work[1] is already familiar.

Both the diagnosis of the agricultural situation and the remedies proposed suggest fields of investigation that have not yet been fully explored, but it is necessary in the first place to be quite clear as to what constitutes in effect agricultural amelioration. It may mean an increase in the proportion of the total population engaged in agricultural pursuits, or in other words an increase in the dependence upon home-grown produce. On the other hand it may mean the attainment by agriculturists of earnings commensurate with earnings in other spheres of industrial activity. Sometimes it seems that Mr. Orwin seeks the one objective, sometimes the other. Unfortunately they may not be mutually consistent. In the matter of employment in agriculture, recent work seems to suggest that it is not corn growing *per se* that gives rise to the higher levels of employment, but rather those systems of farming in which cattle are the medium for the maintenance of fertility of the arable land, or for milk production. The growing of corn, if other means for the maintenance of fertility be adopted, as by the use of artificial manures or by the folding of sheep on forage crops, is consistent with comparatively low levels of employment. The tractor and the combine operating on farms of large area still further reduce the labour requirements of corn land. Turning to specialised production, as opposed to the more intensive forms associated with diversification of output, this is found to be characteristic in world agriculture either of the " extensive " exploitation of virgin lands, as in Canada and Western United States, or it is associated with the availability of cheap labour, as on the rubber and sugar plantations or amongst the cotton-growers of the southern United States. The principle of specialisation applied to agriculture in more highly industrialised countries like our own is not necessarily to be justified merely by examples which arise in areas in which physical conditions impose limitations on production, e.g. on the rough hill grazings where store sheep are raised, or by the successful exploitation of sheltered forms of agriculture, e.g. milk production near to large centres of consuming population. Market gardening, which is quoted as an instance of specialisation, is in effect an extremely diversified form of farming. In contrast with overseas production generally, it may perhaps be claimed that British agricultural practice is an adaptation to conditions which permit of " intensive " production, and that this is normally associated with diversification of output, having greater stability on the whole on that account. It is not as if land were cheap to rent in this country : it is dear on account of its alternative use for houses, shops and factories; it is not as if labour were cheap : that is dear because there are alternative employments for the workers. This means that production must be heavy, in the face of competitive prices, to make ends meet. And it may well be doubted if the more specialised producers, either on the Continent of Europe or in more distant fields with cheaper labour or cheaper land, achieve levels of income offering favourable comparison with earnings of farmers in Great Britain. Indeed, the Inter-American Conference on Agriculture, Forestry and Animal Husbandry, meeting in Washington only last autumn, resolved with unanimity " that crop diversification is of paramount importance for the improvement, development and stability of the economic and social life of the American nations."

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[1] *The Tenure of Agricultural Land, opus cit.*

There are invaluable lessons to be learned from the pioneer work of Mr. Baylis and others in corn-growing, of Mr. Hosier in dairy farming and of others in different spheres of agriculture, in demonstrating the efficiency of simplified systems of working on a comparatively large scale. They have shown that in certain lines of farming and in certain environments general industrial principles can be applied with success to agriculture. It may not, however, be valid to deduce either that the principle of specialisation is of general application in this country, or that if it could be applied the number of agriculturists or the value of the agricultural output would be maintained. The very failure of the efforts of these pioneers to make any impression upon the practices of other farmers, even on neighbouring lands, can hardly be attributed solely to lack of initiative in the farming community. It may suggest either that conditions predisposing to success are limited in their incidence; or it may be that such procedures are inconsistent with maintaining on the land the *number* of people which it is one of Mr. Orwin's objectives to protect. Undoubtedly there will be areas in which some form of large scale enterprise may be inevitable if cultivation in any form is to be maintained. In particular this may apply in districts where good grass cannot be obtained in an average year either as permanent or rotation pasture. The principles of industrial economics are apt to find a testing ground in agriculture : nature has so much to say and human traditions too, and these may be fickle or conservative, intransigent or irrational. What is true or applicable under one set of conditions and for one group of people may not be equally true or function equally well elsewhere. Indeed to disturb the present form of agricultural organisation over wide areas where farming, even at current prices, is yielding a reasonable living to considerable numbers of farmers on a relatively small scale, might well be to create more serious problems than those that are solved.

The chronic disability under which agriculturists the world over work in seeking to maintain their standards of life, is that there is always a full supply of farmers and workers available, whose labour is constantly in competition with new forms of mechanical aid to agricultural production. Such conditions in other industries also have caused, and still are causing, temporary depression and dislocation. Agriculture is meeting a new phase in machine development, in particular as applied to the harvesting of grain, and its effects are felt in the old world and in the new. The row-crop tractors and the combine harvesters are threatening the economic existence of a large proportion of farmers in the Middle West United States as well as of cereal growers in this country. The progress of invention cannot be denied, and few will quarrel with the concept that the future of grain growing lies with the mechanised farm. It may be right to wish to make the operation drastic and get it over quickly. But, as against that, the development of agriculture, its extent and its organisation, represent in the long run a balance between economic advantage and national habit and tendency. Revolutionary change may sometimes be justified—again in the long run—but evolution is a less painful process. Such evolution is taking place, as witness the phenomenal changes in Scottish agricultural practice in recent times. Fortunately in our own country grain has no longer its early significance as a staple product, and there may be justifiable hesitation in embarking upon any widespread changes in the direction of larger farms so long as the rearing and feeding of live stock for the home market remains the dominant characteristic of British agriculture. It should not be overlooked that under the stimulus of an industrial environment agricultural enterprises are, on the whole, much larger in scale here than in countries where the proportion of the population engaged in rural pursuits is greater. Even if further change in this direction should be inevitable it would be optimistic to hope that it could be brought about without further upsetting the balance between urban and rural industry. It is just the old dilemma over again, more agriculturists or a better standard of living. It does not yet seem possible to make the best of both worlds.

But any doubts as to the universal application of Mr. Orwin's diagnosis to the agricultural position in this country, or as to the general suitability of large and specialised farms in a densely populated country like our own, do not vitiate the case for extended inquiry into the economic structure and success of agriculture at home, or for some measure of State encouragement to the experimental application of new methods. Adaptation to meet the situation created by the present level of prices and of costs will be painful enough in some districts to make the testing of practicable alternatives almost a national duty. The necessity for inquiry and experiment lies in the simple needs of the present situation whatever may be its causes.

Mr. Orwin, in the preface to his book, anticipates some measure of disagreement with his conclusions, and he is wisely content to leave the future to prove him right or wrong. Whatever be the verdict of coming years upon the soundness of his judgment, his book is a stimulus to thought and enquiry, and its literary form and clearness of exposition make it extremely pleasant reading. Agriculturists owe Mr. Orwin a great debt for the descriptions of the methods by which modern pioneers have mapped out new avenues of agricultural progress. Many will draw silent inspiration from their work in aid of perhaps less ambitious, but nevertheless sure, advance in their farming methods.

THE BIOLOGIST on the FARM.—No. XLII.

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The Wayward Dandelion.—If the dandelion were not so common, we should appreciate it more adequately for what it is—a very beautiful flower. Of course it is not really and truly a flower, for it is an inflorescence—a crowded collection of strap-shaped flowers, the five notches at the top of each strap plainly indicating that five petals have gone to make the transformed corolla. The perennial root, which does not die even when one cuts it across and carries off the rest of the plant to be burned, contracts as it grows and thus pulls the very short stem portion close into the ground.

What a bundle of adaptations is a dandelion! Thus it is interesting to notice how the bracts below the inflorescence roll backwards and downwards when the fruits are ripe, leaving these well exposed on the broadened convex top of the flower-stalk, whence they are readily detached by gusts of wind. Each fruit is a nutlet with a single seed, and the silken hairs, believed to represent a calyx, are borne on the tip of a much elongated beak, forming the dainty and effective parachute of the dandelion "clock." How well the pappus of composites secures seed-scattering is all too plainly proved by the thistles on our fields and the dandelions on the lawn.

The milky "juice" or latex, contained in much branched vessels, remains a bit of a puzzle. It is a very complicated watery emulsion, containing proteins, sugars, gums, alkaloids, and so on and so forth; but the botanists do not seem very certain whether it is a transport system, like our blood-vessels, or whether it serves for storing, or whether its main use in some cases is not as a deterrent to hungry animals.

As we mentioned once before, the dandelion is somewhat variable in its reproduction. Pollen from the stamens of one strap-shaped floret may pass to the pistil of another floret, thus effecting cross-fertilisation; or pollen from the stamens of one floret may pass to the pistil of the same floret, thus effecting self-fertilisation; or the egg-cell inside the ovule may develop without being fertilised by a pollen nucleus or male element. In other words, parthenogenesis may occur, and it seems to be very common. It is also well known in some hawkweeds (*Hieracium*) and in mountain-everlasting (*Antennaria*), but it is very rare among flowering plants. One of the remarkable features about parthenogenesis (the development of an egg-cell without fertilisation) is its widespread occurrence in the animal kingdom —among insects (as in gall-flies and saw-flies and green-flies), among small crustaceans (as in "water-fleas"), among worms (as in certain threadworms), and very commonly in the class of Wheel-animalcules or Rotifers. It looks as if males were much less indispensable than we think they are! It looks as if parthenogenesis had evolved over and over again in different corners independently, probably by some change in the constitution of the egg-cell, which stimulates it to divide, or removes some hindrance to division, or makes it more permeable to surrounding influences. Another remarkable feature is the twentieth century discovery that this parthenogenetic development can be brought about artificially in a variety of ways—e.g. by altering the chemical and physical characters of the medium, and that it can be made to occur in types which never exhibit it, so far as we know, in natural conditions. Frog's eggs are the highest known to show artificial parthenogenesis. It has been effected in a few plants, e.g. the water-fern, Marsilia.

The Significance of the Commonplace.—We have just referred to the commonest flower that blows, the dandelion, and from what we have said it is plain that a little exploring leads us into deep biological waters, such as the conditions of parthenogenesis or virgin birth. But the same is true all round, though some forms of life are no doubt more interesting than others. There is a fine record of Field Natural History in Britain, but perhaps it is not even now realised that beyond studies of habits and inter-relations there are great opportunities for deep biological study open to those who live in the country or can readily go there. Darwin had his *Beagle* voyage, like so many famous naturalists, but we must not forget that he did most of his work at Down in the midst of a quiet countryside. Pasteur was a laboratory investigator, no doubt, yet we can see that he owed some of his strongest impulses to rural impressions in his boyhood. His recognition of the vital importance of fermentation was not unrelated to his youthful familiarity with wine-making, the dungheap and the tanyard. There are biological problems which would be dark indeed were it not for the study of the sea, and there are lessons from the Tropics which cannot readily be learned in Temperate countries, yet for some kinds of biological study it may be said that stay-at-home conditions are best. This may be illustrated by Fabre's observations of the intimate life of the insects of an apparently unpromising corner of France, or by the Abbé Trembley's story of the fresh-water Hydra, which he watched so perfectly and so biologically in the pond of a garden at The Hague, or by Gilbert White's appreciation of earthworms, or by Miall's investigation of the life-history of common water-insects, or by Tregarthen's description of the home-life of otter and badger, or by Miss Frances Pitt's field ecology—unsurpassed on its own particular line of analysing animal behaviour.

It is undesirable to exaggerate a point like this, for how impoverished our Zoology would be without the Pearly Nautilus and the Lancelet, Peripatus and the King Crab, without its microscopy and cell-lore, without its biochemistry and so forth in many directions; but it will be generally agreed that for the study of habits and inter-relations (ecology) and for the study of life-histories (embryology) and for the study of such evolutionary factors as Natural Selection and Isolation, there are unsurpassed opportunities in the countryside around us, not forgetting, of course, such streams and lakes as the particular locality may include. What great results Darwin got out of by no means unusual hedgerows (with their climbing plants), meadows (with their bee-visited orchids), marshes (with their sundews), grass fields (with their earthworms), and copses with their struggle for existence! Day after day he walked round and round the wildness of a little wood (the path now happily preserved for the pious); how much this must have meant for his prescient appreciation of the commonplace.

On many occasions in past years " the Biologist on the Farm " has sought to illustrate this theme, that from the common sights and ongoings of any countryside even the deepest biological problems may be studied. Nature bristles with marks of interrogation if we could only see them—translucent question-marks among the leaves of grass and the petals of flowers, among the feathers of birds and the hairs of mammals—marks of interrogation everywhere!

What interest there is in cuckoo-spit and the cuckoo's shouting, in the hedgehog's hibernation and the lady bird's quiesence on our finger tip, in the "language" of bees and the bee-line for home, in the cat's hair standing on end before a dog and in the cat's colour-blindness, in the success of leguminous plants in poor soil and of the heather on the hills, in the twining of tendrils and in the showers of gossamer. And how much there is still to know about each and all!

Countryside Conundrums.—Perhaps we may venture to ask a score of the questions which crowd on us,—some concerned with inter-relations or ecology, some with physiology, some with evolution-lore, and so on. Any reader can cap our score, and the longer the list the better, for the world of life bristles, as we have said, with marks of interrogation! We have deliberately avoided any logical arrangement of our riddles.

(1) *Why is cuckoo-spit common in early summer, but scarce later on?* Because it is made by the larval phase of the froth-blower (say *Aphrophora spumaria*), who ceases by and by to be a frog-hopper and flies away.

(2) *Why do a cat's eyes shine in the dark?* So we were asked last week by a naturalist along another line of activity. The answer must be that in a perfect " dark room " they do not shine at all, though in an ordinary dark room they do. They are then reflecting the scanty rays of light, which are usually present in what we call darkness. There is, of course, no production of light on the cat's part, only a reflection. The power of reflecting is not confined to cats—one has only to look at a sheep in a dark byre to see the shining eyes—but it is particularly marked in cats and some other nocturnal mammals because of the fine development of a mirroring surface or *tapetum lucidum* in the retina. It is also well seen in some fishes, and probably enables the possessor to make the most of poor light. So we say that the cat " sees in the dark."

(3) *Do voles ever grow old, or do they continue slowly growing until they come to a violent end while still in the prime of life?* This interesting question must be cautiously answered at present; but the strong probability is that voles show no senescence and go on growing till they are devoured. Is this true of many other wild mammals?

(4) *Where do the large water-beetles (Dytiscus), common in ponds, undergo their metamorphosis?* The hungry larvæ with powerful jaws are familiar in the water, but they make holes in the banks and become for a long time thoroughly terrestrial. All the terrestrial stages—from burrowing larva to metamorphosing pupa and on to fully-formed beetle—have been finely photographed by Mr. Hugh Main, who has no small degree of Fabre's

observing genius; and this underground phase of life is of much interest to the general biologist because the Dytiscus-like water-beetles show in other ways, more markedly than many of the aquatic insects, that they are derived from terrestrial ancestors. The larvæ go back after a while to the old ancestral haunts.

(5) *How is it that leguminous plants improve poor soil?* Because bacteria which form and inhabit tubercles on the roots of plants like clovers, vetches, rest-harrow and lupine are somehow able to capture and fix the free nitrogen in the soil-air and soil-water, so that organic nitrogenous substances are formed. When the plants are ploughed in and decay ensues, the nitrogenous content of the soil is increased.

(6) *How is a bee able to make a bee-line for its hive?* One must admit, to begin with, that the bee does not always make a "bee-line," for it may be diverted by wind and other difficulties. Yet one may say that it tends to go straight home, and often does so. Experiments show that this is because it has served an apprenticeship to the area around the hive, and follows certain finger-posts which it sees.

(7) *How is it that the heather succeeds so well on unready moorland soil where only a few plants can survive?* According to Miss Rayner and others, though there remain some critics, the success of the heather is due to a partner-fungus which penetrates it through and through and enables it (in some way still uncertain) to make the best of the deficient nurture.

(8) *What is the meaning of the roughness of a cat's tongue?* In feline carnivores the ordinary conical or threadlike papillæ on the dorsal surface of the tongue are unusually strong and hard, being slightly horny. If a cat licks our finger we feel it a little like sandpaper, and a lion's licking will soon draw blood. The first point is that the cat's rasp is due to a slight transformation in the ordinary tongue papillæ belonging to the conical or filiform type. This is a common kind of change in evolution—from a more generalised to a more specialised type of structure. The second point relates to the use of these stiff tongue-processes; and the usual answer is that they help the cat or any other "feline carnivore" in rasping the little tags of muscle-insertion from off the bones of its prey. This may be true in part, but perhaps the processes have a greater utility in the creature's toilet, serving as brush and comb to keep the sleek fur in good order.

(9) *Do adult salmon never feed in fresh water?* Perhaps the answer should be "hardly ever." Their food-canal seems to be out of gear, and not in a state for digestion. The stomach is usually empty and the intestine shows no debris of food. They are utilising reserves accumulated during their stay in the sea when their appetite is large. Some anglers maintain that "kelts" (salmon spent by spawning) often devour other fishes, even of their own kind; and they certainly recuperate. But one of the most scientific of the anglers, Mr. J. Arthur Hutton, says:—"I, for one, am convinced that kelts take very little, if

any, food while in the river." But if salmon do not feed in fresh water, how is it that they take the fly and other lures? Are they like children who have no appetite for their porridge, but cannot resist a bit of bacon? Are they like fasting friars who have no difficulty in resisting the dry bread, but a good deal in not casting longing eyes on the pasty? We must remember also that the very strangeness and unexpectedness of a peculiar bait, like an artificial " minnow " or an entomologically impossible " fly," may pull the trigger of the gulping instinct irresistibly.

(10) *Why is it that a bat in hawking insects of an evening often falls for a couple of feet or so in the air?* Miss Frances Pitt's answer is that the bat has caught a high-flying beetle or the like in its jaws, but its booty is still alive. How is the bat to give the insect a second bite without losing it? It bends its head downwards and backwards and presses the booty against a triangular flap of skin, usually developed between the thighs and supported in the middle line by the tail. Then it can open its mouth and bite again; and during this moment of preoccupation it tumbles a little in the air. The flap of skin is known as the inter-femoral membrane, and may also serve as a temporary basket.

So we might continue, and exhaust the printer's supply of marks of interrogation! (11-20) Do guinea-pigs ever sleep, and if not, why not; do horses dream; why does a dog turn round and round on the hearthrug; how do certain mammals find their home from a distance; why does a hen advertise its egg so loudly? How does a lady-bird feign death, or at any rate remain for a long time motionless and irresponsive to touch; how many birds have a sense of smell; how is it that partridges and some other close-sitting birds are able to suppress their scent during incubation; why do horses shy; and why do owls hoot when they are not courting?

Triumphs of Instinct.—As one goes about the country just now, when life is at full tide, one sees many instances of triumphant instinct, sometimes perfected, we think, with a gleam of intelligence. At other times one sees the efficiency of instinctive behaviour defeating itself by its tyrannous routine, as when an Indian file of Procession Caterpillars, bent round to make a circle, continues in futile circumambulation for hours and hours. Oftenest, however, it is the successful efficiency that we have to admire. Thus we came across a horizontal web which a spider had constructed over a sluggish ditch banked by willow-herbs. The ditch was broader than we could jump, and the bridge was suspended about a yard above the water. It was more than a bridge, of course; it was the usual insect-snaring web, a swaying sheet approachable from either bank. So far as we understand, it is impossible to account for the making of such a bridge-web, in a situation which could not be walked round, except on the assumption that the spider took advantage of currents of air which wafted across the first strand or strands.

From one side she paid out a thread of silk which she fastened where she stood, facing the direction from which the breeze blew. When the silken thread was long enough, its free end became entangled among the herbage on the far side. In all likelihood a second thread was made parallel to the first. Then the spider crept cautiously across the swaying line, paying out more silk and strengthening the first threads as it went, and then pulling taut on the further bank. After that, all was easy—for a spider. The result was certainly an achievement commanding our admiration, and we have no doubt that we could see a bridge in process of being made if we went often enough to a suitable place where spiders abound. If the achievement stood alone, it would be almost necessary to regard it as an expression of high intelligence, but it is led on to by a gradation of minor accomplishments which we know to be instinctive, that is to say, the outcome of inborn hereditary capacities for going through an effective routine, requiring no apprenticeship. Thus a young garden-spider can make a web true to type the very first time it tries. There is no 'prentice hand, for though a stronger web is afterwards made, there is no fumbling with the first, and the pattern is that characteristic of the species. Instinctive behaviour is a ready-made capacity.

In his admirable " Problems of Instinct and Intelligence " Major R. W. G. Hingston tells us of a spider, called *Araneus nauticus*, which wove a 22-inch web across a Himalayan pool. In so doing it emitted 122 feet of silk thread, made 699 attachments, and travelled over a distance of 178 feet,—the whole work taking only thirty-six minutes.

Major Hingston has probably seen more different kinds of instinctive behaviour than any other living naturalist, and his conclusions must receive every consideration. One of them, one that commends itself to us, is that intelligence not infrequently intervenes when instinctive routine is endangering the creature's life. Another, but one which we cannot accept, maintains that instinctive behaviour has evolved from intelligent behaviour that has become automatised. The facts of heredity seem to us to be quite against this interpretation of instinct as *lapsed intelligence;* and there are other great difficulties, such as the extreme and remorseless inflexibility that instinctive behaviour often exhibits. It is often so fatal that it seems to us to tell against Hingston's theory that " instinct began in a reasoned act." If it did, how is it in many cases impossible or extremely difficult to awaken any hint of the originally intelligent learning. But Mr. Hingston's answer is that the automatisation has become so thorough that it cannot be departed from, and he gives many illustrations of this. Thus, keeping to spiders, he tells us of one, called *Sparanus lutescens*, which makes a very neat spiral nest out of a blade of grass, and fixes its egg-bag inside. Hingston took out the egg-bag or cocoon and placed it on a free part of the grass-leaf in the hot sun. The spider could have retrieved it in a moment; it was only half an inch away;

some related spiders rise to the occasion at once. But what this particular species does is to shoot out threads of silk and fasten the cocoon in the glare—which is rapidly fatal. " A creature can fashion that elegant spiral, yet it has not the wit to pull its egg-bag inside. When anything happens to go wrong with her egg-bag, all she can think of is anchor and fix. Pulling would require a slight gleam of originality, and her instinct is too limited for this." Well, well!

A Placental Hormone.—Professor Collip's inquiry into the occurrence and function of a hormone in the placenta was, he tells us, an outcome of a visit which Dr. B. P. Wiesner, of the Department of Animal Breeding in Edinburgh University, paid to the Biochemical Laboratory at M'Gill. Professor Collip's results " may be said to be built upon and to be the outcome of the earlier work of Wiesner and his collaborators."

Active extracts of an ovary-stimulating hormone (" emménin ") have been obtained from the human placenta, and it is believed that the hormone is of placental *origin* as well as occurrence. The effects of the hormone are analogous to those produced by the anterior hypophysis. A reference is made to the work of Cole and Hart, who showed that anterior pituitary hormone is present in the blood serum of mares during part of the gestation period. But Collip and his collaborators have not obtained any active extract from the placentas of ordinary mammals, and the suggestion is made that the placenta has acquired new endocrine functions in the Primates. To test this they are making experiments with monkeys. So far it looks as if the human placenta produced a specific hormone ("emménin"), closely similar to the hormone produced by the anterior lobe of the pituitary body. Its injection into immature female rats resulted in the production of " heat " (œstrus) and of corpora lutea. If this conclusion is confirmed, some important applications may perhaps be found practicable. From the zoological side we would suggest that precise inquiry be made into the occurrence of placenta-eating in various mammals. Some interesting result might be reached.

MILK LAMB PRODUCTION IN SCOTLAND.

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One of the main trends of modern animal production is towards the early maturing animal. The scientific basis of the economic advantages of early maturity is well known. To quote Armsby (1): " It makes a very material difference, however, to the producer of beef cattle, for example, whether a calf averaging 100 lb. at birth has the capacity to reach a weight of 1,200 lb. at two years old, or whether he requires three years to do it.

This is not, however, because there is any material difference in the amount of feed which the animal requires to manufacture the 1,100 lb. of increase. The difference as regards feed cost comes in the expenditure for maintenance, since each lb. of gain, as well as the original 100 lb., must be maintained from the time it is laid on until maturity."

In theory, shortening of the period during which a maintenance ration has to be supplied makes early maturity an invariable advantage in feeding. In practice, however, a longer period of feeding on cheap feed may be more profitable than a shorter period on expensive concentrates. In this country the basis of meat production is the feed produced on the farm, pasture in summer, turnips, straw or hay in winter. Unless these basal feeds are of a certain minimum nutritive value, attempts at forced feeding will not pay.

It is unfortunately true that meat production is influenced, not only by the economics of the farm, but by the consumer's caprice. There are fashions in food as in clothes. The future hopes of the Scottish sheep farmer are based not so much on the suitability of his country for sheep, as on the British people's fondness for mutton. In 1928 the per capita consumption of mutton and lamb in the United Kingdom, in lb., was 25·1, compared with 5·6 in the United States, 6·8 in France, and 1·6 in Germany (2). The per capita consumption of mutton has declined in all countries since the pre-war period, which in Great Britain was then 29·3 lb. The decline of 4·2 lb. is less than one might have anticipated, considering the high price of mutton during the post-war period and the smaller type of joint generally used.

It is probably true to say that had mutton remained mutton, the per capita consumption would have fallen considerably. In this country mutton is eaten only by those unable to afford lamb. This is also true of the United States. "In marked contrast to the large supply of lamb offered during recent years, it is significant that almost universal testimony has been supplied by many old time buyers of sheep and lambs that prior to 1904 very few lambs were slaughtered, the bulk being yearling wethers, ewes and mature animals " (2).

In Scotland the virtual disappearance of adult wethers from the markets, and, therefore, from the hills, has had important effects on the whole sheep industry of the country. Fat sheep are now sold either as lambs or hoggs; since the distinguishing mark of a lamb carcase—the break joint of the foreleg—persists until the animal is twelve to fourteen months old, it may be said that the bulk of Scotch mutton is already sold as " lamb."

The public of twenty years ago was apparently contented with the flesh of mature wether sheep; the public of to-day prefers mutton from sheep less than one year old. It can be confidently stated that the public of to-morrow will demand mutton from sheep under six months of age, for in palatability, tenderness and appearance it is infinitely superior.

It cannot be too strongly emphasised that the industrial districts of England offer a wonderful market for mutton. " Of the total exports of frozen mutton and lamb from all countries in 1925, 273,000 tons or 92 per cent. were imported into the United Kingdom, and only 22,000 tons sent to other countries. Of the total consumption of butcher meat in the United Kingdom, estimated to amount to about 2,000,000 tons per annum, about 25 per cent. consists of mutton and lamb. In no other country in the world is mutton eaten to anything like the same extent " (3).

Unfortunately, although the British people eat mutton, it is not always British mutton. An ever increasing quantity comes in the frozen state from abroad. About 50 per cent. of the mutton eaten in this country, and about 80 per cent. of that eaten in London, is imported from abroad.

The London lamb market has fallen very largely into the hands of New Zealand and Argentine. It would be absurd to suggest that this is because of a public preference for frozen mutton. It is often said that frozen lamb is indistinguishable from fresh. It would be truer to say that a prime milk lamb frozen is equal to a grade hogg fresh. New Zealand lamb has had phenomenal success because :—

(1) An increasing proportion is " milk lamb "—that is lamb sold direct from the ewe.

(2) It is relatively cheap.

(3) It is a relatively standardised product.

If the Scottish farmer could produce a standardised fresh " milk lamb " it would certainly command a better price because of its unfrozen state. It may be argued that New Zealand is a sheepman's paradise, that grass grows throughout the year, and that costs of production are therefore lower. While this is admittedly true, it is also true that land values in New Zealand are very high, and that the price received for their product is relatively low. At the present time a North Island farmer is receiving 25*s*. for each fat lamb (4). The " tops " from a Blackface hill will yield as much to the producer.

The Scottish farmer cannot produce fat lambs at 25*s*., but he has a wide margin to work on. At the present time a Scottish fat lamb of the right weight and in the right market should fetch double that price.

The Production of Milk Lambs.—In the belief that the future of mutton production lies in the milk lamb, and that the Scottish sheep feeder must aim at such production to compete successfully with frozen imports, an attempt was made in the years 1929 and 1930 to run an ordinary arable sheep stock with this aim in view.

In the first place it was realised that the importation of Dorset sheep, with their unseasonal behaviour, was a totally unpractical experiment. The Dorset is a useful breed for producing an early lamb, expensive to produce and catering for a very special market —a market which would collapse immediately the supply exceeded the limited demand at a remunerative price. Accordingly Greyface ewes (Border Leicester × Blackface), already available on the farm, were used and were mated with Oxford Down rams. In the second place very early lambing was not attempted. The first lamb was dropped on the 10th of March. Even then it was found difficult to procure economical feed, as the grass in 1930 was very tardy in growth. If early lambing is adopted, it is better to lamb really early, use Dorset blood, and cater for the special market.

Method of Management in Oct. 1929-*Oct.* 1930.—Ewes were put to the tup on the 10th October. Clover aftermath was used for flushing and the ewes came rapidly to the tup. During tupping the rams received a daily allowance of 1 lb. crushed oats with a little linseed cake meal. Four rams were used among the 105 ewes. There was no necessity to use more than three, but the fourth happened to be available. Twelve acres of aftermath were eaten. The ewes were on it for three weeks and left it rather bare.

After the clover was eaten, they were put on an old lea field until the end of tupping. At the end of tupping the ewes were in good condition, and no turnips or concentrates were fed until the end of January. Where ewes are in good condition at the commencement of winter, and if the winter is moderately open, no feed except grazing should be necessary until six weeks or a month before lambing.

Concentrates were first fed on 27th January. The following mixture was used :—

Bruised oats	17 parts.
Bran	10 ,,
Linseed cake meal	4 ,,
Steamed bone flour	1 part.

Cod liver oil, 1 gallon to 10 cwt.

The mixture was fed in troughs at the rate of ½ lb. to 1 lb. per head per day right through lambing.

Turnips were fed from the beginning of February onwards. They were carted off the turnip break and fed to the sheep on lea. While this is probably a more healthy practice than netting in-lamb ewes on a break, it involves more expenditure on labour.

The ewes were exercised each day during the last month of pregnancy, being driven into rough hill grazing for a few hours daily. Lambing took place in March and in the beginning of April. After lambing, ewes and lambs were run over the small amount of young grass available, fed 1 lb. per day of the meal ration detailed above, and had swedes carted to them on the grass. There was very little grazing available until the middle of April.

Ewes and lambs were then put on grass plots managed on the Hohenheim system of rotational grazing. Turnips were discontinued, and the meal ration changed to one of the following composition :—

Bruised oats	1 part.
Ground barley	1 ,,
Ground maize	1 ,,

This is a ration of low protein content; it is in fact a carbohydrate concentrate. According to Woodman *et alii* (5) forced closely grazed pasture is in the nature of a diluted protein concentrate. Such pasture, unbalanced, will scour sheep badly. Supplementing with a carbohydrate concentrate, however, corrects this tendency, and the enormous advantages of intensive rotational grazing become available for sheep. On such pasture both ewes and lambs make very rapid gains in weight. The rotational grazing used was primarily laid down for the use of dairy stock on the farm, and was available for sheep only until the cows were put out to grass. A week before the cows went out, the rotational plots were cleared to allow the grass to come up.

On the 15th of May the sheep were transferred to good permanent pasture, mainly cocksfoot, ryegrass and wild white clover. The pasture, although of good quality, was never luxuriant.

Lambs were castrated with the knife at from a fortnight to a month old. The bloodless castrator is not recommended for lambs intended for the fat market.

Ewes and lambs were fed together and no hurdles were erected. If sufficient troughs are provided and a little trouble taken, the lambs can soon be induced to eat along with their dams. Better results would probably be obtainable with hurdles or creeps. At the same time, in fat lamb production, it is even more important to feed the ewes than to feed the lambs. It is more essential for the ewe to milk freely than for the lamb to eat meals. No amount of concentrates can satisfactorily replace ewes' milk during the first months of life.

From May until the end of July the sheep were run on these lines. The basis of feeding was pasture, which was never superlatively good, and during June suffered severely from drought.

From the 19th of May onwards the concentrate ration was changed to one of the following composition :—

Barley and maize (kiln dried) crushed ...	6 parts.
Bruised oats	1 part.
Earth nut cake crushed	1 ,,
Mineral cake	½ ,,

The cake was used because of its protein content. Good pasture in itself contains sufficient mineral matter for production requirements (10).

The cake had the following composition :—

	Parts by weight.
Steamed bone flour	350
Ground limestone	150
Salt	150
Ferric oxide	50
Soya bean meal	200
Ground nut meal	250
Decort. cottonseed meal	100
Linseed cake meal	70
Cod liver oil	100
Potassium iodide	0·251

The lambs were dosed with worm tablets (copper sulphate and arsenic) at monthly intervals. The importance of *regular* treatment for worms cannot be overestimated. They affect every sheep stock, and even though lambs appear to be thriving quite well, they will thrive very much better after treatment.

The first lamb was ready for the butcher on the 8th of May. Further lambs were drafted out throughout May and June. All these lambs were singles. The remainder of the single lambs were sold fat on the 7th of July; 119 of the twins were sold fat a month later on the 6th of August. The 14 lambs remaining to be sold were weaned. On the 5th September one was sold fat, and the remaining 13 sold in the store market.

As the lambs were sold the ewes were drafted out, milked once, and put on the barest pasture available. Even then they got very fat by the autumn, and the effects of such fatness in breeding ewes was sufficiently important to warrant a separate investigation. The results are discussed later, but it may be mentioned here that fatness at mating time apparently had no influence on the breeding power of the ewes.

It is not claimed that the method outlined above is beyond criticism, nor that it cannot be improved upon. It is not claimed to be in any way original or revolutionary. It is described merely as the method employed yielding the result desired—a high percentage of fat " milk " lambs—that is fat lambs sold direct from the ewe to the butcher. The economy of the method is discussed later.

Results.—The mortality among highly fed ewes is often said to be excessive. The annual percentage mortality of the 105 ewes on the experiment was 6·3, which, although high, is not excessive.

Two ewes were barren. They were sold in the fat market immediately after lambing, without special feeding, and realised a good price.

185 lambs were born. Of these 12 died before sale. The lambing percentage was thus 1·66, and the percentage mortality of the lambs 6·4.

From 105 ewes there were sold 174 lambs—1·65 lamb per ewe, or 165 per cent.

Of these lambs 159 were " milk " lambs sold direct from their mothers. The percentage of milk lambs was thus 92.

In New Zealand on an average 50 to 60 per cent. of the fat lambs are killed direct off their mothers (6).

The following instance is quoted as showing what can be done on good land in New Zealand in the way of milk lamb production :—

> " A line of 815 ewes with 845 lambs; 805 of these lambs were drafted fat off their mothers on 2nd January 1925, and netted 35*s*." (6).

That is a milk lamb percentage of 95, compared with 92 in the present Scottish experiment. On the other hand, the New Zealand ewes reared only 1·04 lambs per ewe, compared with 1·55 in the present experiment.

The relative price of the lambs is illuminating, 35*s*. for the New Zealand fat lamb, 50*s*. 8*d*. for the Scotch. There is a good margin there to cover greater costs of production.

The average weight of the lambs at sale was 93 lb. Dead weights of all lambs are not available, but from those determined it may be assumed that the average dead weight was somewhere above 50 per cent. of the live weight—i.e. 46·5 lb. The latter figure compares quite favourably with that of New Zealand, where the lamb carcases are said to average 35 to 45 lb. dead weight.

There are thus sufficient grounds to warrant the conclusion that by rather intensive management, including flushing on clover aftermath, rotational grazing on early forced grass, and the continuous feeding of concentrates to ewes and lambs from February to August (six months), it is possible to bring " milk " lamb production in Scotland to the high level of the New Zealand industry.

The system of management in the year October 1929-October 1930 has been recorded in detail. In the previous year, 1928-29, the first year of the experiment, methods of management were similar, but the production results—as shown in the following table—were not quite so good.

Year.	*1928-29.*	*1929-30.*
No. of breeding ewes	121	105
No. of lambs sold	169	174
No. of lambs sold per 100 ewes ...	139	165
Percentage of milk lambs	82·8	92
Average price per lamb	48/-	50/8
Gross return per ewe	74/-	82/-

In the present year 1931, lamb creeps have been introduced in order to economise in concentrates and to bring the lambs more rapidly to the butcher. The ewes are fed ½ lb. meals in the morning, the lambs feeding along with the ewes. In the evening the lambs only are fed, ¼ to ½ lb. per head for each lamb. The creeps, which allow of the lambs being fed separately, are home-made, fencing stobs, flakes and rope being all that is required.

Economics.—It has been shown that intensive management gave successful production results. But the question immediately arises—Is it a profitable policy to pursue?

Detailed costing figures were calculated for the two years ending 31st March 1931 and are given in the following table :—

FAT LAMB PRODUCTION.

Financial Returns for two years ending 31st March 1931.

Dr.				*Cr.*
Valuation of animals, 31st March 1929		£364 12 0	Sales of ewes and skins ...	£78 14 7½
Purchases of animals ...		194 17 6	Do. wool	66 4 0
Cost of rams		25 2 10	Do. 343 lambs	842 17 1
Labour		88 0 3	Manurial value of foods ...	7 15 11
Foods:			Valuation of animals, 31st March 1931	380 16 6
Grazing ...	£205 5 3			
Turnips ...	62 0 11½			
Concentrates	82 8 8			
Hay and straw	7 11 11	357 6 9½		
Equipment (upkeep and depreciation)		16 3 0		
Miscellaneous expenses (dipping, &c.)		34 6 2		
Net Profit		295 19 7		
		£1,376 8 1½		£1,376 8 1½

		Total costs for two years.	*Cost per ewe per annum.*	*Cost per lamb sold.*
Depreciation on ewes		£33 14 4½	£0 3 0	£0 1 11½
Cost of rams		25 2 10	0 2 3	0 1 5½
Labour		80 0 3	0 7 9	0 5 1½
Foods:				
Grazing ...	£205 5 3		0 18 2	0 12 0
Turnips ...	62 0 11½		0 5 6	0 3 7½
Concentrates and fodder, less manures	82 4 8		0 7 3	0 4 9½
		349 10 10½		
Equipment		16 3 0	0 1 5	0 0 11
Miscellaneous expenses		34 6 2	0 3 0½	0 2 0
		£546 17 6	£2 8 4½	£1 11 10½

Average sale price per lamb	£2 9 1½
Do. cost price per lamb	1 11 10½
Do. profit per lamb	0 17 3
Do. profit per ewe per annum	1 6 2

NOTES ON COSTINGS.

1. *Valuation.*—Ewes are valued on a fixed price basis. Gimmers are valued at 50*s.*, and the difference between this figure and the purchase price is written off at the time of purchase.

One crop ewes are also valued at 50*s.* From then onwards the ewes depreciate by monthly fractions until they are five years of age, when their book value stands at 25*s.* No further depreciation is allowed for.

2. *Cost of rams.*—This figure includes depreciation of the rams, food and labour.

3. *Grazing.*—This figure includes rent (30*s.* per acre), pasture manures, cultivation, &c.

4. Costs per ewe per annum include the cost of rearing ewe hoggs until they reach breeding age.

Over the two years the average cost price per lamb sold was 31*s*. 10½*d*. and the average sale price was 49*s*. 1½*d*., a net profit per lamb of 17*s*. 3*d*. Where a farmer does his own shepherding the net profit per lamb sold would be 22*s*. 4½*d*. The average net profit per breeding ewe kept works out at 26*s*. 2*d*.

Under the conditions of the experiment, the venture was thus very definitely profitable.

Discussion.—It has been shown that intensive management of Greyface ewes results in a large percentage of lambs being sold direct from their mothers. Neither specially good sheep nor especially good land are necessary to obtain this result.

The system is an economic proposition under the conditions of the experiment. Whether it would be equally profitable on any particular farm is a question for the individual farmer to decide in considering his whole system of management.

A subsidiary question of importance is the effect of forced grass and heavy concentrate feeding on the ewes. Regarding the ewe as a machine for lamb production, it is obvious that the greater the number of lambs, and the heavier the lactation, the greater the depreciation of the ewe. It follows that the effects of forced production on the ewe must be carefully studied.

When ewes are weaned in May or June they become fat by the following mating season in October, a condition that might possibly affect their breeding power. To determine this point, in the summer of 1929, all ewes weaned before the end of June were specially keel marked. The number of lambs they produced was compared with that of those ewes weaned in July or later. It was anticipated that if early weaning influences breeding power unfavourably the lambing percentage of early weaned ewes would be lower than that of those weaned later.

The results showed that 32 ewes weaned before July produced 52 lambs, and that 79 weaned in July, or later, produced 133 lambs, a lambing percentage of 162 in the early weaned ewes and of 168 in those weaned later. In fact, early weaning had no bad effect on fertility in the following year.

A common criticism of the system was that the ewes " stood about doing nothing during half the summer." This criticism implies a totally wrong attitude towards the physiology of the breeding ewe. If a ewe milks heavily and produces a milk lamb in June, she has the remainder of the summer to increase her stores of calcium, phosphorus, protein and fat. She is in a better condition to stand the winter and to produce a strong lamb in the following year. The long fallow period in the annual cycle of the ewe should do much to counterbalance the depreciation caused by forced production during pregnancy and lactation.

It has been said that heavy concentrate feeding of ewes during early summer is apt to cause liver degeneration and death from " twin sickness " in the following pregnancy. It is exceedingly probable that heavy feeding and forced production place a greater strain on the important organs of the ewe than does production of a store lamb. It is certainly true that twin disease or toxæmia of pregnancy is more likely to arise under intensive conditions of management than under more natural treatment.

It follows that cases of this disease are to be anticipated, although regular daily exercise will do much to check its incidence (7). The fact that a certain disease is liable to follow a system of management otherwise desirable is no argument for abandoning the system of management. It is rather an argument for research on the causation and prevention of the disease.

In considering the possibilities of expanded lamb production, one must also bear in mind certain points of trade interest which affect the problem.

Home produced lamb has an advantage over home produced beef in that it has to compete only with the imported frozen article. Chilled beef is a more serious competitor in the home market than frozen beef, and commands a 20 per cent. higher price (8). At the present time practically all imported mutton or lamb is frozen, and the chilling of imported mutton or lamb does not seem to be a probable development. Home killed fresh milk lamb has thus to compete only against frozen milk lamb from abroad.

During the seven months ended December 1930 English second quality lamb averaged 11⅝*d.* per lb., compared with 9⅛*d.* per lb. for New Zealand first quality frozen lamb, a difference of 2½*d.* per lb. in favour of second quality English lamb over first quality New Zealand frozen lamb (9). Moreover, a decline in prices of imported mutton and lamb is not necessarily accompanied by a decline in the price of the fresh home killed article (9). It is quite evident that, other things being equal, the British public prefers fresh lamb to frozen lamb, and is willing to pay more for it. From the relative independence of the home market in lamb, it certainly appears that an expansion of milk lamb production in Scotland might be advised without much risk of knocking the bottom out of a market which is reasonably good at the present time.

Conclusions.—On an arable farm of only moderate fertility 90 per cent. of Oxford × lambs from Greyface ewes were sold as milk lambs direct from their dams to the butcher. A certain expenditure on pasture manures and concentrates was necessary to obtain this result. In the years of the experiment, 1929 and 1930, and on the particular farm where the work was done, the procedure was found to be profitable. The profit in any year naturally depends not only upon the production results, but on the relative prices of concentrates and lamb.

Perhaps the majority of arable sheep farmers in Scotland depend upon the autumn store sales as a market for their lambs, which are bought for winter feeding, or in the case of ewe lambs, for breeding. At such sales the price of any particular lot of lambs is fixed very largely on "character," that is, on the confidence of buyers in the sheep stock and their owner.

A man taking up sheep for the first time or in a small way will receive better value for his product if he can fit it for the fat market. To a butcher a fat lamb is a fat lamb and is bought chiefly on its merits.

For a small farmer with four or five score sheep and reasonably good grazing the production of fat milk lambs is a good proposition at the present time. Satisfactory results can be obtained from quite ordinary breeding stock, and expensive tups and gimmers are unnecessary.

Summary.—(1) " Milk " lamb—that is lamb sold fat direct from the ewe—forms an increasing proportion of mutton imported to this country, and is the type desired by the meat trade.

(2) Milk lamb production may be made a successful and profitable undertaking in Scotland.

(3) The production of milk lambs demands the feeding of concentrates on pasture to both ewes and lambs from before lambing until the lambs are sold.

(4) It is possible to sell over 90 per cent. of lambs fat direct from their dams, even when 50 per cent. of the ewes are nursing twins.

(5) The strain imposed upon the ewe is admitted, and certain precautions in management are advised.

(6) It is argued that the British market could absorb an increased supply of home produced milk lamb without a collapse in prices resulting.

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AGRICULTURAL SURVEYS.

(*Continued.*)

CONCLUDING SUMMARY.

BEFORE reviewing the main features of the reports on the agricultural surveys which have been carried out by officers of the Department of Agriculture for Scotland during the past few years, and of which summaries have already appeared in this Journal, reference may again be made to the scope and object of the surveys and the methods adopted in carrying them out. In all, seventeen parishes, situated in nine counties, have been surveyed. The object of the surveys was primarily to describe the state of agriculture in the various districts. So far as practicable every holding in the selected parish was visited and as much information as possible was obtained from the occupier, such as the conditions of tenure, the numbers and kind of stock kept, the yields of crops, particulars as to seeds, manures and feeding stuffs purchased, methods of management adopted, labour employed, financial results, and indeed in regard to all matters affecting the holding. The reporters also in many cases personally examined the stock, stackyard, steading and houses, farm equipment, fencing, condition of the arable and grazing land, &c., and in other ways supplemented and corroborated the information given by the occupier, so that the reports provide a very full account of the state of agriculture in the various districts. As a general rule information was readily given by the occupiers and in quite a number of cases detailed records and accounts were made available to the reporters. In the present article it is intended to review briefly the general conclusions arrived at over all the districts, and in view of the number of different areas surveyed, and of the fact that the districts were carefully selected as being typical of larger areas, it is hoped that the general conclusions will prove of value to agriculturists. It should be emphasised, however, that owing to the wide variations in conditions even within a comparatively restricted area, and to the fact that each farm has, as it were, an individuality of its own, any generalisations may require to be considerably modified in their application to particular farms.

The total area included in the surveys was approximately 700,000 acres. Of this area 390,000 acres were used for agricultural purposes, 250,000 acres for deer forests, the remainder being occupied by woodlands, inland water, roads and railways, sites of villages, &c. The agricultural area was made up as follows :—

Arable land	60,000	acres.
Land under permanent grass	22,000	,,
Mountain and heath land used for grazing	308,000	,,
	390,000	,,

The holdings numbered 1,070, of which 560 were classified, according to the Annual Agricultural Returns, as under 30 acres. Before examining the general conclusions of the reporters in regard to the state of agriculture, mention may be made of the use to which the holdings under 30 acres are put. Nearly half of them are accounted for by the crofting townships in Sutherland. The results show that about 10 per cent. are not really independent small holdings, but consist merely of grass fields or pieces of land worked with larger holdings. Probably not more than 10 per cent. are occupied by able-bodied persons depending entirely for their living on the holding. In a fair proportion of these cases the classification of the holdings as being under 30 acres is rather misleading owing to the fact that for this purpose no account is taken of rough grazing land. In this group therefore are included sheep farms with only a small acreage of arable and grass land, the other holdings mainly consisting of intensively worked poultry and dairy holdings, nurseries and market gardens. It is estimated that 30 per cent. of the holdings under 30 acres of arable and grass land are occupied by retired persons, old age pensioners, or persons with private means or in receipt of assistance from relatives, while 50 per cent. are occupied by persons with other occupations in addition to farming. While this last-named group consists of holdings which cannot support a family, there is no doubt that they are very important. Sometimes the holding provides the main support of the family, but in other cases the holdings provide the subsidiary employment which is necessary to the pursuit of some other occupation. Without the steady work and cheap living provided by a holding it would frequently be impossible for other forms of industry to be pursued, as for instance fishing in many of the crofting districts and the various trades and occupations (e.g. blacksmith) in other districts. Consequently it would seem important from the point of view both of the individual and of the nation that suitable holdings of this nature should be available.

Turning now to the general findings of the reporters it may be stated that, while on the whole the standard of agriculture is reasonably high, wide variations exist not only in comparing one district with another but also in comparing one holding with another in the same district. In this connexion it has to be borne in mind that from the individual farmer's point of view the object, in the majority of cases, is not primarily to obtain the maximum production but rather to secure the maximum net financial return from the holding, and this determines the direction and scope of his activities. Broadly speaking, the financial results were more satisfactory in the better farmed and more progressive districts than in the districts where the holders seemed less capable and less progressive, but very great differences were also revealed in comparing the financial results of adjoining farms. For the purpose of this article the factors which may be held to account for these differences have been classified into two groups, viz., those factors which are mainly or generally under the control of the farmer and those factors which are mainly or generally outwith his control. With regard to this classification it will, of course, be appreciated that in view of the complicated nature of agriculture the various factors are often so interlocked with one another that it is difficult to make a hard and fast classification which would apply to all individual cases.

A. FACTORS MAINLY OR GENERALLY UNDER THE CONTROL OF THE FARMER.

1. **System of Management.**—*Crops.*—The main feature under this heading is undoubtedly the tendency to lay down more

land to grass either by lengthening the rotation or by reducing the area under the usual rotation. This tendency has of course been evident for many years in Scotland. About sixty years ago, when official statistics of crops and stocks were collected for the first time, the proportion of land under rotation grass to the total arable land was less than 40 per cent.; in 1930 the proportion was nearly 50 per cent. That is to say, the average rotation has probably lengthened from one of five years, with two years' grass, to one of six years, with three years' grass. These broad averages of course cover innumerable local variations. Not only, however, has the area under grass been increased by lengthening the rotation, but the acreage under permanent grass also has shown a progressive increase, at the expense of arable land, the acreage returned in 1930 being the highest on record. The main reason for this movement since the war is given by the reporters as the need for reducing labour costs, which have increased more than proportionately to any increase in the revenue. Another important reason is that a greater area under grass facilitates the rearing of young stock, particularly sheep, which have been more profitable than some other classes of stock in recent years.

The whole question of rotations is engaging the earnest attention of many farmers, and as indicated in the reports on the Dumfriesshire and Wigtownshire parishes new rotations are being tried with a view to overcoming, for instance, the difficulties experienced with lea corn as a result of sowing wild white clover. The crux of the matter is of course costs and the relative returns from crops and stock. As noted in the report on the Kincardineshire parishes, a comparison of the financial results indicates that long grass rotations, especially in the poorer districts, are more suited to the times than short rotations. In other districts, too, it would seem that the rotations might often be still further lengthened with profitable results, though at the same time in a number of districts (Wigtownshire, Ayrshire and Argyllshire) the reporters suggest that more forage crops might be grown with a view to reducing the cost of purchasing feeding stuffs. It may also be noted that the reporters recommend the growing of seed potatoes in several districts.

Stock.—As with crops, so in the case of stock changes are taking place in the systems of management and the relative importance of the various classes of stock. Needless to say, horse breeding has diminished considerably, while in general cattle, sheep and poultry have been receiving more attention. With the development of transport facilities more farmers have been enabled to concentrate on milk production for either wholesale or retail sale. In view of the varied systems of cattle management, largely determined by local conditions in the different districts, no common feature emerges from the reports which calls for special comment, except that where it was possible to compare cattle breeding with cattle feeding the former system has been found to give the better financial results in recent years, and in certain districts the reporters suggest that there is room for the development of cattle breeding. As has already been noted, sheep have been more profitable than some other classes of stock in recent years and consequently there has been a decided increase in the numbers of sheep kept. In 1930 the total number in the country was the highest on record. In some districts the reporters state that the problem of fencing is one of the greatest obstacles to the keeping of sheep. For consideration of certain questions concerning sheep and deer one must turn to the summary of the report on a parish in the Central Highlands (JOURNAL for October 1930).

It is satisfactory to note the increasing interest which is being shown by many farmers in their poultry, and indeed on numbers of farms where poultry were formerly of little significance this branch is now occupying an important position in the economy of the farm. Notwithstanding the substantial development which has taken place in recent years, however, the reports show that there is room for considerable development of this branch on many holdings in practically all districts.

Pigs present a difficult problem, but it is clear from the reports that usually this class of stock occupies a very minor place in the system of husbandry practised in most districts and that there is scope for development. Apart from the question of prices and disease, one of the main difficulties in the way of the development of pig-keeping is the initial cost involved in the provision of proper accommodation. In the one district surveyed in which comparatively large numbers of pigs are kept (viz. in Wigtownshire) the general system of management adopted is far from satisfactory.

2. Skill in Management.—This factor may be conveniently treated apart from the system of farming adopted, though obviously it has to be kept in mind that the farmer who is skilled in the various processes of plant and animal husbandry is generally the most able and ready to modify his system to meet changing conditions. An examination of the general conclusions in the reports reveals some features which are encouraging and others which are less satisfactory and indicate a lack of progressiveness and adaptability.

One encouraging aspect of the reports is that in practically all districts the reporters found a number of keen progressive farmers who were consistently practising good husbandry and who were fully alive to new ideas and possible improvements. On the holdings occupied by these farmers the reporters found the highest crop yields, the finest pastures and the best quality of stock, and the reporters generally found that, while the less capable farmer might in these difficult times be losing money, the skilled farmer was at the worst making ends meet.

On the other hand we read :—" a number of the farmers lack knowledge of the first principles of breeding " ; " the farmers were lacking in up-to-date knowledge of manuring " ; " many of the farmers did not appear to understand the principles of manuring and feeding and the selection of grass seed mixtures." The principal directions in which criticism is made by the reporters may be summarised as follows :—

Grass Land.—While grass land husbandry is increasing in importance in Scotland, as in Great Britain generally, and is indeed occupying in some ways the predominant place in agriculture formerly occupied by cereals, it is a striking feature that the most definite criticism is directed towards the management of grass land, whether it be rotational, permanent or rough grazing land. There is criticism, sometimes very strong, in regard to grass land in every parish surveyed, and while all districts do not come in for the same criticism, fairly widespread lack of knowledge is evident in regard to—

(*a*) The selection of suitable mixtures. (The compounding of seed mixtures is often left to the seed merchant. The value of wild white clover is still frequently not fully appreciated.)

(*b*) The general treatment of grass land, particularly as regards manuring (e.g. with a view to increasing the early and late growth of grasses).

(*c*) The management of stock on grass land.

The result of the present neglect is that the yields of hay are sometimes very low and the grazing capacity of pastures frequently restricted. In the words of the reporters :—" it is not inconceivable that the hay crop might be increased by 50 per cent."; " in some districts the second year's grass was poor in the extreme "; " large areas of the older grass land were under rushes and other areas were reverting to a natural state "; " probably at no time within the past forty years has the condition of many of the permanent pastures been worse than it is now."

Manuring of Crops.—In some districts there is a lack of knowledge of up-to-date methods of manuring. The reporters also suggest that economies could be effected in many cases by the home compounding of manures and by a better selection of manures. For instance they state as follows :—" We were of opinion that farmers all over in this parish could effect considerable economies in regard to their manure bills. It frequently occurred that expensive manures like sulphate of ammonia were applied to the turnip crop in far too large quantities to give the most profitable returns."

Cattle.—(i) *Breeding and Rearing.*—In several districts the class of cattle bred is poor and there is room for a general improvement in the matter of quality. The first principles of breeding are not understood by some farmers. The reporters emphasize the importance of eliminating cross-bred sires and scrub bulls, and while in many cases care may be taken in the selection of bulls, less discrimination is generally employed in the selection of females. In the Argyllshire district the reporters suggest that advantage could be taken more widely of the premium bull scheme of the Department of Agriculture for Scotland.

(ii) *Feeding.*—There is no doubt that in many cases better results would be obtained if more attention were paid to feeding. In the case of one of the Berwickshire parishes "few farmers could state the actual daily quantity of cakes and meal given, and in some instances the quantities given by the cattleman were found on weighing to be considerably larger than the farmer's estimates." In the case of the same parish the reporters also question the advisability of feeding such large quantities of roots. It is satisfactory to find that attempts are being made to make more use of home-grown feeding stuffs, but there is no doubt that there is room for development in this direction with a view to the partial replacement of cake by cheaper forage and silage crops.

(iii) *Milk Production.*—The wide variations in the yields of milk in the dairying districts surveyed show that there is considerable room for improvement in regard to milk production. The reporters suggest that more attention should be paid to :—

(*a*) rationing according to yield;
(*b*) milk recording;
(*c*) the selection of bulls from good milking strains.

Sheep.—In some districts the quality of the sheep stocks might be improved, particularly by the use of better rams, and greater attention generally paid to the management of this class of stock. It is clear from the reports that numbers of farmers are not keeping in touch with the latest methods for the treatment of diseases, e.g. the use of carbon-tetrachloride. The question of sheep diseases is of course closely bound up with other factors, such as the condition of the grazings as regards nutritional value and the state of the drainage. The importance of proper feeding of the ewes prior to lambing and of the ewes and lambs after lambing is frequently not fully appreciated.

Pigs.—The very definite impression received from the reports is that pigs receive little attention owing to the fact that, as indicated above, they are generally of little account in the system of husbandry practised. Even where they are of more importance—as in the cheese-making parish of Wigtownshire surveyed—the system of feeding is in some cases wasteful.

Poultry.—It is gratifying to note that increasing interest is being taken by many farmers in their poultry and very creditable results have been achieved. At the same time it is clear that on far too many farms the poultry still consist of the nondescript barn-door type and that there is room for considerable improvement.

Management of Labour.—Striking differences are revealed in comparing one farm with another in regard to labour. Sometimes the differences may be partly attributed to unsuitable steadings, but there is no doubt that in many cases there is a lack of skill in the economic use of labour. This does not mean that it is desirable to employ cheap labour—in one of the districts surveyed a notably high standard of efficiency in the organisation and management of labour was associated with decidedly higher wages than in other districts.

These criticisms by the reporters emphasise the need for agricultural education. That it is no easy matter, however, to reach many farmers is evident from the observations of the reporters in regard to some districts, e.g. in one of the Berwickshire parishes—" the attitude towards agricultural education was in general apathetic," and in the Argyllshire parish—" a large number of the farmers are either unreceptive of new ideas or uninstructed in modern methods." It is no doubt the case that a fair proportion of those whose holdings are poorly managed are men of advancing years, and their attitude towards agricultural science is sometimes disappointing. On the other hand the work of the agricultural colleges is noted as having had very good results in several of the districts surveyed. An interesting and important feature, brought out in one of the districts, is the great influence for good that one progressive farmer may have on others. In some directions where improvement is not being made it may be necessary for the State to bring compulsion to bear on farmers with a view to the adoption of better methods, as, for example, in regard to the elimination of scrub bulls.

3. **Drainage.**—The reports show that the proportion of land requiring draining varies considerably in the different parishes. Over all the districts the proportion of arable and grass land requiring tile drainage (either by way of repairs to the existing drains or by redrainage) works out at about 12 per cent. The average proportion of hill drainage required cannot be given, but it is clear that in most districts extensive stretches of the rough grazings would be greatly improved by drainage—to the undoubted benefit, also, of the health of the sheep stock. While in some districts a good deal of work had been done under the Department's scheme for the assistance of agricultural drainage, in other districts little advantage had been taken of the scheme up to the time the surveys were carried out. In the case of the Argyllshire district the reporters express the opinion that the Government scheme is having a good effect on the larger farms, but that the occupiers of the smaller farms are apparently too poor to take advantage of the scheme, as they cannot find the cash to pay the requisite two-thirds of the cost. In one or two districts, the reporters note, some proprietors were in the habit of supplying tiles free of charge, but notwithstanding this inducement, little drainage had in some cases been done. In a number of areas faulty arterial drainage was causing trouble, sometimes fairly serious, but in view of the increase in the number of proprietors involved, it was in most cases becoming extremely difficult to arrive at an agreed scheme of improvement. It is hoped, however, that the provisions of the Land Drainage (Scotland) Act, 1930, will now enable improvements to be effected.

4. Liming.—Generally speaking, it was found that practically no liming had been done in recent years, although the remains of old lime kilns frequently indicated that at one time liming had been extensively carried out. Definite soil tests were carried out by the reporters, and their main conclusions and suggestions may be summarised as follows :—

(1) In most districts a large proportion of the land seems to show a marked deficiency in lime.

(2) Further research is required into the whole question of soil acidity and lime requirement in relation to plant growth, and also into the effect of lime deficiency in soils on the health of stock. There should also be local experimental and demonstration work.

(3) The application of lime to the non-arable land, much of which contains peat in varying quantities, is, owing to the inaccessible nature of such land, in most cases outwith the scope of practical economics. The only feasible method of treatment is the cutting of hill drains.

(4) The possible use of electricity in some districts is suggested in connexion with the reopening of lime quarries and the establishment of lime grinding plant for the production of ground limestone.

(5) It is suggested that co-operative action, with the help possibly of the State, might be taken by farmers for the purchase and erection of grinding machinery.

Special attention has been given to the question of soil acidity, and following on the general agricultural surveys, the Agricultural Colleges carried out acidity surveys of the parishes in Berwickshire, Dumfriesshire and Wigtownshire, and articles on these soil surveys appeared in the JOURNAL for July 1928 and October 1929. An important step with regard to research work on soils was taken last year by the establishment at Craigiebuckler, Aberdeen, of the Macaulay Institute for Soil Research. Experimental and demonstration work on liming is also being carried out by the Agricultural Colleges.

5. Bracken, Scrub and Whins.—In some of the districts surveyed bracken is giving serious trouble, and the evidence indicates that it is increasing. In the Argyllshire parish it is a very serious pest, not only from the point of view of reducing the stock-carrying capacity of the land, but because it helps to conceal sheep affected with maggots and is also probably an indirect cause of an increase in fluke disease; bracken occupies the higher and drier land, and sheep are therefore inclined to seek food on the lower and wetter areas. Interesting observations were made by the reporters, in connexion with the survey of the Perthshire parish, on the relationship between the growth of bracken and the burning of heather, indicating that the systematic burning of heather does much to keep bracken in check. It may be mentioned that, following on the appearance of a disease in bracken, the Department of Agriculture for Scotland and the West of Scotland Agricultural College are pursuing the investigations into the possibility of the control of bracken by this means, but no definite results have yet been obtained. At present the best known method of eradication is to cut the bracken regularly over a period of years.

The spread of scrub is giving some trouble in Argyllshire, while in some of the other districts more could be done to keep whins and rushes in check on the rough grazings.

6. Heather Burning.—While the position with regard to heather burning is fairly satisfactory in some districts, in others considerable criticism is made by the reporters with regard to this matter. In the Perthshire district it was found that insufficient burning was carried out—so far as the interests of the grazing tenants were concerned—and that in fact it was quite impossible for the limited number of gamekeepers to burn the moors sufficiently. The conclusion of the reporters with regard to the position in this district is that burning can be carried out efficiently only if the right to burn be delegated to the grazing tenant and his employees. Under the Heather Burning (Scotland) Act, 1926, a grazing tenant may apply to the Department of Agriculture for Scotland for an order authorising him to burn heather, but only two applications have been lodged with the Department up to the present time. The reporters suggest that the fact that little advantage has been taken of the Act is partly due to the fact that many of the tenants are without leases.

7. Co-operation and Marketing.—In ten of the seventeen parishes surveyed there is co-operative buying or selling in varying degrees of the following commodities, viz. :—

3 parishes—buying of manures, feeding stuffs, seeds;
4 parishes—sale of milk to creameries or milk distributing agencies;
2 parishes—sale of sheep (by crofters in two Sutherlandshire parishes);
1 parish—sale of wool.

In the other seven parishes there is little or no co-operative action with regard to the purchase of requirements or the sale of produce. There is no doubt that there is a strong individualistic attitude, more commonly found amongst the larger farmers, which makes co-operative buying or selling in many districts difficult. In the case of many of the more capable farmers this is partly due to the opinion that they can get as good, if not a better, price for their products by private sale. In other cases the attitude largely springs, no doubt, from a desire amongst farmers to keep their affairs to themselves or simply from a love of individual bargaining. There is also the important question of financial accommodation, it being obvious to the reporters that many farmers were practically tied customers or clients of certain firms, both in regard to buying and selling.

It is evident, however, that the present methods of buying and selling in many cases are far from satisfactory. For example, in the Wigtownshire parish the store pigs are in many cases supplied by merchants who later buy the fat pigs, the price of the stores often being quoted after delivery. In the same way, in another district the reporters state that some farmers buy store cattle from auctioneering firms and these are the property of the auctioneers until paid for, usually when they are sold fat. The reporters were very emphatic about the unsatisfactory nature of cheese marketing in the cheese district surveyed, the farmers being very much in the hands of the merchants, and little attention being paid to the question of grading.

As the questions of co-operation and marketing are largely affected by local conditions, such as the proximity to markets, it is hardly possible to generalise in respect of the suggestions of the reporters, but attention may be directed to the following points :—

(1) It would be in the general interest of the farmers if there were more co-operative buying and selling.

(2) With regard to certain products, such as eggs and cheese, there is scope, and in some cases an urgent necessity, for collective grading and organised marketing.

(3) Transport difficulties in certain districts may be largely overcome by co-operation.

B. FACTORS MAINLY OR GENERALLY OUTWITH THE CONTROL OF THE FARMER.

1. Instability of Prices.—This factor, it will no doubt be agreed, ranks first in importance at the present time in considering the principal factors which are mainly outwith the control of the farmer. In the reports on the various districts figures are sometimes given showing fluctuations in prices which have taken place since pre-war days. Broadly speaking, it may be stated that while the main items of revenue, with some exceptions, have declined to about pre-war level, many of the items entering into the cost of production, particularly wages, still show a marked increase over pre-war figures. The general question of prices is, of course, outwith the scope of the agricultural surveys carried out, but the reporters indicate that matters are not improved by the present methods of marketing, and that producers might derive considerable advantages from co-operation and orderly marketing.

2. Farm Steadings.—The main conclusions of the reporters may be summarised as follows :—

Kincardineshire (4 parishes).—On the whole the farm steadings are substantial and commodious, but good accommodation for pigs is seldom provided, and there is a lack of proper implement sheds and covered courts in some districts.

Aberdeenshire (3 parishes).—The farm buildings are generally well built and substantial, but in many cases the accom-

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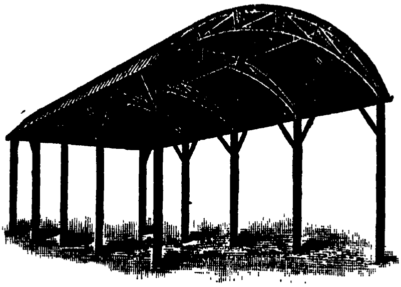

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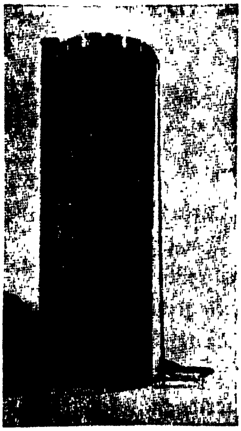

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modation has not kept pace with the increase during the past twenty years in the numbers of stock kept.

Ayrshire and Dumfriesshire (3 parishes).—Generally speaking, the situation and accommodation of the steadings are satisfactory, and apart from minor alterations required mainly to improve ventilation and lighting, the byres are generally of a good standard.

Berwickshire, Wigtownshire, Argyllshire and Perthshire (5 parishes).—Many of the buildings are old and could be improved by rearrangement and reconstruction to meet modern requirements and to save labour. Many of the byres in the Wigtownshire and Argyllshire parishes are very poor. In many cases the present rents will not provide for the necessary repairs to be carried out.

Sutherlandshire (2 parishes).—In this area most of the buildings are owned by the tenant (usually a small holder). While great improvements have been effected in recent years, the standard is low.

3. Farm Housing.—In most districts the farm houses are, on the whole, stated to be good substantial buildings, though in some districts modern conveniences are frequently lacking.

With regard to farm workers' houses, in many of the districts there is undoubtedly a lack of houses for married workers, and even many of the existing houses are far from satisfactory, one of the main defects being dampness. One aspect to which the reporters draw attention is that the provision of good houses attracts better workmen and also does much to reduce the tendency to change at term time, which is common in some districts and which is often of no benefit to the farmer or the employee. " When the houses were good, it was said that the men never left."

4. Limitations of Soil, Climate and Geographical Situation.—While these factors may considerably influence the productivity per acre of a holding, they should not normally prevent the holding from being a financial success, because at the outset they should obviously be taken into account in fixing the rental of the holding or the price paid for the holding if purchased. It is not always appreciated, however, that much may be done to mitigate the possible adverse effects of these factors. In the case of the soil for instance, the reporters noted striking differences in the yields of grain and other crops from adjoining fields, the fertility of the soil in one field having been appreciably increased by persistent good farming in the way of a suitable rotation and appropriate manurial treatment. Proper attention to grass land and rough grazings may materially reduce the mortality amongst stock. The reporters also refer to the importance of shelter belts in exposed districts, and there is no doubt that in a number of the districts surveyed judiciously placed plantations would be of considerable value. With regard to the geographical situation of a district, reference may be made to the development of the Orkney egg trade in consequence partly of the necessity to centralise the produce for shipping purposes. In the case of the Argyllshire parish the reporters, as already noted, consider that some of the present difficulties with regard to transport could be overcome by better co-operation amongst the farmers.

5. Conditions of Tenure.—While, theoretically speaking, a tenant should have as much say as the proprietor in regard to the conditions which may be attached to his occupancy of a holding, it is indicated in one or two reports that some farmers are working under unsatisfactory conditions of tenure. In some cases where tenants are sitting on yearly lets or continuing on tacit relocation it is possible that they lack confidence to carry out improvements such as draining, liming or heather burning. Most of the tenants of the larger farms had leases of fourteen or nineteen years, and the reporters refer to the excellent relations that exist between tenants and landlord in some districts. Reference is also made to the high level of management and the superior condition of the steadings, fences, &c. on some estates as compared with others where there is apparently a lack of means. Since the war the number of occupying owners has increased; in some cases there is a lack of capital owing to the necessity to incur bonds, but it is interesting to observe that in one district "owner occupiers were effecting considerable improvements to farm buildings."

6. Damage by Deer.—While the question of damage by deer is of importance only in certain districts there is no doubt that the damage caused in these areas is sometimes considerable, both in regard to crop growing and the keeping of stock. The following quotation from the summary of the report on a Perthshire parish indicates the position in that district :—" On practically all hill lands, apart from those utilised solely for deer, the reporters found deer more or less abundant and quite frequently observed herds of 50 to 150 on relatively small grazings, while on larger grazings greater numbers were seen. . . . but when food supplies are at a minimum, and herds of deer invade the lower wintering grounds of the sheep during the critical periods of winter and early spring, the results are disastrous from the standpoint of the flockmaster."

From this general summary of the reports on the agricultural surveys it is clear that there is room for considerable improvement in the standard of agriculture in the country. The relative effect of the various factors referred to above may and does, in fact, vary considerably in different districts on individual holdings and at different times, but the conclusion of the reporters is that in general, and subject to there being no great and sudden changes in national or international affairs, the main factors in successful farming are those over which the farmer himself has control, and of these the dominating factor, again speaking in general terms, is skill in management and the ability to adapt one's system of management to meet changing economic conditions.

NOTE.—*Article on Agricultural Survey of Two Parishes in Sutherlandshire* (JOURNAL *for April* 1931, *page* 157).

It is regretted that in this article, under "General Remarks," it is indicated that Common Grazing Committees may be elected annually. This is not the case, as the election of these Committees must take place triennially in accordance with the requirements of the Common Grazings Acts. The suggestion that continuity in policy and management would more readily be effected if in certain cases the Committee members retired in rotation every third year instead of the entire Committee being elected annually was intended to refer to the committees of certain credit societies operating in connection with sheep stock clubs.

INSECT PESTS.—XI.

R. STEWART MACDOUGALL, M.A., D.Sc.

WEEVILS—*continued.*

IN our article in the January number of *The Scottish Journal of Agriculture* it was stated that the Weevil section of Beetles contained enemies both of the agriculturist and the fruit-grower. Space allowed only of mention of the Turnip Gall Weevil. In this article we begin by a review of other troublesome weevils.

The Pear-Shaped Clover Weevils.—These belong to the genus Apion, a genus rich in species. The beetles are very small, varying in size from just over $\frac{1}{25}$ inch to $\frac{1}{12}$ inch. The proboscis or beak is long in proportion, and as the little beetles increase in size and width backwards, through head, thorax and abdomen, the shape is suggestive of a pear, the long stalk of which is the proboscis.

Several Apion species are destructive to clover, preventing seed production and causing a withering of the flower heads. Perhaps the most troublesome in the South is *Apion apricans*, black in colour and with bent or elbowed antennæ that spring from near the middle of the snout. By aid of a lens a marked groove can be seen on the head between the eyes.

The tiny weevils issue from their winter quarters at the end of spring and the beginning of summer. The females, after pairing, lay their eggs, singly, in the young unripe flower heads of clover. By a week the eggs have hatched; the resulting grubs live in the flower heads and feed on the ovules and the seed-crop fails. The withered-looking heads call attention to the attack.

The grub is legless and dirty-white, with a brown head; it is full grown in three weeks. Pupation follows in the spoiled heads and by another week the beetles are ready. There are two broods in the year, perhaps more, the beetles of the last brood hibernating.

A British Apion, viz. *A. ulicis*, the Gorse Weevil, has interest for us at this time. The female of this weevil lays her eggs in the young pods of gorse or whin and the grubs feed on and in the seeds and spoil them. Dr. Maldwyn Davies[1] regards this weevil as a potent factor in preventing gorse areas in Britain from spreading. The weevil has been imported to New Zealand in the attempt to keep down the gorse there, which has so spread as to be taking up considerable areas of good agricultural land.

Pea and Bean Weevils.—The Pea and Bean Weevils belong to the genus Sitona. The snout is not drawn out but broadened. A number of Sitona species in Britain are enemies of leguminous crops. Some may keep to one crop plant, but the majority are general feeders, feeding for example on pea, bean, clover, lucerne, vetches, the adult beetles migrating it may be from one kind of leguminous plant to another at different times in the year.

The damage done is twofold. The adult beetles feed above ground on young leaf and shoot. The grubs live in the soil at the roots of plants, tunnelling into and spoiling the nodules and destroying also the young roots.

The beetles because of their somewhat dingy colour evade notice, and the damage they do is ascribed sometimes to sparrows and sometimes to slugs. When disturbed the beetles drop away from the plant on which they have been feeding; they lie motionless, and as their colour harmonises somewhat with the soil the beetles are difficult to pick out. If undisturbed after falling they soon take shelter under clods or in cracks in the soil. Several closely related species of Sitona have been confused with one another. Miss Dorothy J. Jackson, F.E.S., has described the species harmful in Britain to leguminous plants and has worked out life-histories experimentally and in the fields, clearing up a number of debated points.

The species that has come oftenest to me and the one concerning which I have had most complaints is *Sitona lineatus*, the Striped Pea and Bean Weevil. We will take it as the type.

Sitona lineatus measures from one-sixth inch to one-fifth inch in length; ground colour dark, but in fresh specimens the body is covered with greyish or grey-yellow scales; the upper side of the thorax may show three stripes owing to the massing of scales; the wing-covers, in addition to lines of punctures, have variegated scales often arranged to show alternate dark and light longitudinal lines or stripes.

The larva is a typical weevil grub, yellow-white in colour, legless, with curled wrinkled body; the brown coloured, jawed head is followed by 13 joints, the last of which is muscular and of service in progression; the length of the full grown grub is just over a quarter inch.

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[1] The bionomics of *Apion ulicis* with special reference to its role in the control of the Gorse or Whin (*Ulex Europœus*) in New Zealand. By W. Maldwyn Davies, B.Sc., Ph.D., in *The Annals of Applied Biology*, vol. xv, No. 2, May 1928.

Life-history.—The weevils overwinter in the winged adult condition; the shelter places are hedgerows, the surface layers of soil, long grass, clover stubble, stacks of pea straw. From April onwards the weevils leave their shelter-places and appear on the young plants, specially on peas and beans. These individuals, although they have been in the open, in the previous autumn, before passing to their winter quarters, are still unable to pair efficiently. A certain amount of feeding has to be done, necessary for the ripening of the reproductive apparatus and the formation of eggs. Pairing and egg laying follow. The earlier beetles live through the summer, and those that have come from their winter quarters later, because of lower temperatures, live into the autumn. A large number of eggs can be laid in the course of the summer's life of the females. In her experimental work, with Sitona in confinement but with conditions otherwise natural, Miss Jackson [1] found in one case 354 eggs laid, and in another with a longer-living female 1,655 eggs; a Russian worker [2] found 1,481 eggs laid in five weeks. There is considerable mortality, however, particularly among the newly hatched grubs.

The eggs are laid in the soil at the bases of food plants, but they may be laid on leaf or stem, though such eggs lose their attachment and fall to the ground and get covered by soil. Moisture favours hatching. The new laid egg is yellowish white but the colour changes to black.

The newly hatched larvæ move to the roots and enter nodules; older larvæ are found feeding with head and front part of body hidden in the nodules. The full-fed grub pupates in the soil, in an earthen chamber, at depths varying from a half inch down to 2 inches. The weevils, when ready, remain at rest for some days in their pupal chamber, and then make their way to the surface to pass to food plants—peas, beans, clover, and wild perennial leguminous plants. The typical thing is for adults to be ready in autumn so that the winter is passed in the adult condition, but late individuals may hibernate as pupæ. There is no egg laying in the autumn-appearing weevils, which after a time proceed to hibernation. The typical happening is one generation in a year.

The length of time taken in the various stages of egg, larva, pupa varies with the environment. Miss Jackson found the eggs to hatch in a fortnight to three weeks, the length of larval life to be six to seven weeks, and the pupal condition to last from a fortnight to three weeks.

Nature of Damage.—Apart from the spoiling of roots by the feeding of the larvæ, the chief loss is due to the feeding of the weevils in the early part of the season—April and May—when they have reappeared after hibernation. The plants are young and tender; if the weevils are numerous when these young plants are checked by cold or by drought in dry sunny weather then great loss follows and resowing becomes necessary. Sitona damage is easy to recognise as the weevils bite out V-shaped notches round the edges of the leaves (Fig. 1); in heavy onset the leaves are eaten to the midrib, and younger plants totally destroyed.

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[1] Bionomics of Weevils of the genus Sitona injurious to leguminous Crops in Britain, by Dorothy J. Jackson in *The Annals of Applied Biology*, vol. vii, Nos. 2 and and 3, Dec. 1920.

[2] Data for the Study of the genus Sitona (in Russian). Bull. Mleev. Hort. Exp. Station, 1928, by N. A. Grossheim. Quoted in the *Review of Applied Entomology*, Ser. A, vol. xvii, Pt. 8, August 1929.

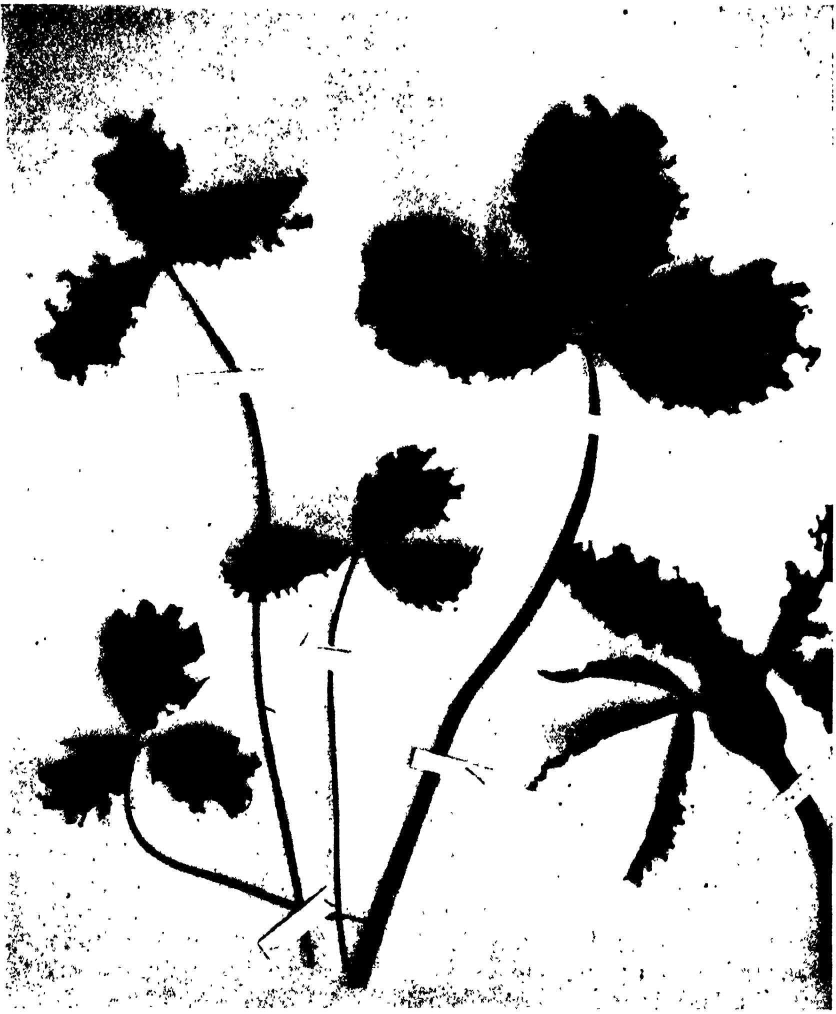

FIG. 1.

Leaves of clover injured in characteristic way by Sitona adults. (From Nature.)

Control.—Control is difficult when the insects are in mass. In a favourable season for the young peas and for beans, plants not severely attacked grow away from the damage.

A mixture of lime and soot distributed over the young plants after dew or rain gives some protection.

Spraying the young plants with arsenical washes and with paraffin emulsion are practised, the plants so treated proving distasteful to the weevils, or the weevils are poisoned if they eat the leaves. Grossheim, the Russian author already quoted, recommends, against *S. lineatus* and allied species, a spray of Paris Green, 1 lb. to 120 gallons of water, and also a 4 per cent. solution of barium chloride.

In nature Sitona is partly held in check by Braconid parasites and also by a fungus. In the controlled conditions of a laboratory Miss Jackson found the fungus *Botrytis bassiana* extremely destructive to *S. lineatus.*

Other Sitona species.—There are related Sitona species sometimes found at work with *S. lineatus* on the same food plant, sometimes with preference for other than pea and bean. The species, however, are confusing and need special work for their separation. In any attempted distinction of species the student should work with weevils that have not been long in the open and have not been so rubbed as to lose the scales and bristles and hairs, which, along with shape and pattern of sculpture, have been used to afford characters for the separation of species.

On the whole the various species of Sitona resemble in habit of life, but there are differences, e.g. *S. hispidula,* a darker species than *lineatus* and keeping more to clover, may hibernate in the egg stage as well as in the adult condition, and as it does not take so long to ripen its reproductive organs, *hispidula* may proceed to lay eggs in the season of its first emergence.

WEEVIL ENEMIES OF FRUIT.

The Apple Blossom Weevil (*Anthonomus pomorum*).—The work of this beetle has been known in Europe for over a hundred years. The harm is done to the blossom; flowers infested by the grub fail to open and the rust or brown-coloured withered petals (the affected flowers look as if they had been frosted) catch the eye; the disease is known as "capped blossom."

The beetle is a small one measuring a quarter inch in length; there is a prominent snout near whose tip are the elbowed antennæ; a very characteristic broad V-shaped greyish mark is present towards the hind-end of the wing-covers.

The weevils hibernate as adults in the moss and other growth on trees that are neglected, under bark scales, in crevices in bark, in rubbish heaps. They come out in spring. The females lay their eggs in the unopened blossom, one egg to a flower. Should the flowers expand rapidly the grub that may have hatched from the egg and is thus no longer sheltered, dies. Specially in weather unfavourable for the opening of the blossom the hatched grubs get a start and the flowers are so spoiled that they fail to open. The full-fed grub pupates in the unopened withered blossom. There is one generation in a year. The life-history is passed through rapidly. The beetles that issue from the spoiled blossom feed for a time in summer and then go into winter quarters.

Control.—Control is difficult as the insect has no very vulnerable stage. The best results are obtained by trapping the beetles. Bands of sacking are tied round the trees in June and left till autumn. The weevils use these bands as places for their winter rest. Experimental work at East Malling showed that great numbers of the weevils were caught in the removed bands.

While the Apple Blossom Weevil is found in the north, it is most abundant from the middle of England southwards.

The Anthonomus Weevil of Raspberry and Strawberry.—A local name for this troublesome beetle is the " Elephant " or the " Snout " beetle owing to the very evident snout or proboscis. The weevil measures one-tenth inch excluding the snout; it is black with greyish hairs; the thorax is punctured and the wing-covers lined and punctured. The larva is of the typical weevil form, with rather hairy body.

The life-history resembles that of the Apple Blossom Weevil. A bud is punctured and an egg laid. To prevent the unfolding of the bud, which would deprive the grub that hatches of shelter, the weevil after laying an egg punctures the stalk of the bud. Buds attacked by the weevil show they have been interfered with, for they soon droop as a result of puncture.[1] The grubs feed in the unopened buds and pupation follows in the place of feeding. The adult hibernates.

Watch should be kept for the first appearance of the beetles in spring—April and May—and these should be shaken off the plants into dishes that are tarred or contain paraffin.

The Otiorrhynchus Weevils.—Otiorrhynchus is a genus of wingless weevils with a short thick snout. The three species concerning which most complaints are made are the Clay Coloured Weevil (*O. picipes*), the Black Weevil (*O. sulcatus*), and the Red-legged or Plum Weevil (*O. tenebricosus*). These three species are harmful both as adults and as grubs. The adults gnaw and puncture leaves and shoots and fruits, while the grubs live in the soil and spoil plants by feeding on the roots. These beetles do not confine themselves to a particular species of plant but are general feeders. There are numerous records of damage to raspberry, strawberry, plum and other rosaceous fruit plants in the open, to the tenderer fruit plants under glass, and to ornamental trees and shrubs. These weevils feed at night and hide in the daytime. *Otiorrhynchus picipes* is the most troublesome of the three, and we will describe it as typical of the others, which more or less resemble in habit of life.

O. picipes measures one-quarter inch to about one-third inch (the other two are somewhat larger); in shape the beetle is oblong-ovate, with elbowed antennæ that arise from near the tip of the short thick snout; the body is covered with an ash-grey pubescence. The wing-covers (there are no functional flying wings) are rough and clothed with greyish scales, which, when examined with a lens, are seen to be beautifully arranged like a piece of mosaic work. To the unaided eye, however, the beetle appears unattractive; it may be described as clay-coloured, and when it falls to the ground—and it does so very readily when an infested plant is shaken or jarred—it is not easily detected.

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[1] **Fenoulhet and Theobald in *Report on Economic Entomology* for the year ending April 1907. S.E. Agric. Coll., Wye.**

This weevil is an enemy of fruit trees and bushes and is also troublesome in plantations of trees other than fruit trees. The adults bite out the buds and gnaw the bark of shoots; raspberry, apple, plum, strawberry, damson, rose-stocks, as well as a number of broad-leaved species of tree are used as food plants; one of my correspondents sent me examples of twigs, oak, spanish chestnut, ash, hazel and birch all "ringed" in characteristic way by the weevil.

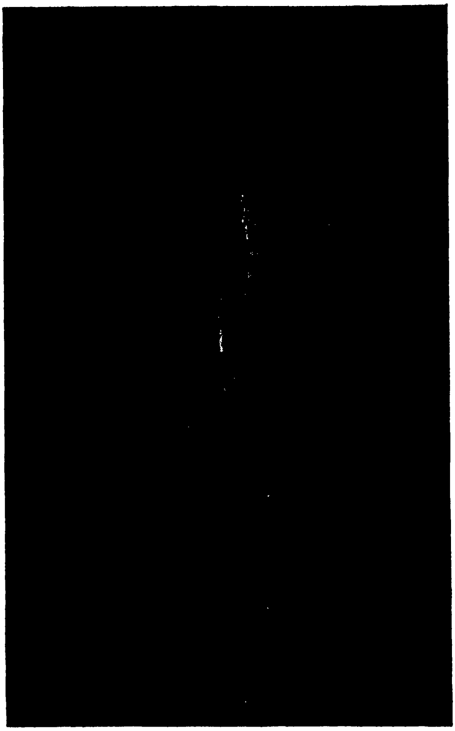

FIG. 2.

Begonia tunnelled by grubs of *Otiorrhynchus sulcatus.*

The eggs are laid in the soil and the larvæ, typical weevil grubs, gnaw the roots. The winter is passed in the larval condition sometimes in the adult stage. With the wintering larvæ pupation takes place in spring.

I know *O. sulcatus* more as a pest of garden and greenhouse plants, the grubs destroying the roots, into which they bore (Fig. 2). Primulas, begonia, cyclamen, maidenhair fern have come to me with the plants dying. Where the plants were in pots, on the soil being shaken out groups of larvæ were found. From these grubs I bred out *O. sulcatus*.

Phyllobius Weevils.—Phyllobius is a genus of small weevils with a thick or broadish snout of only moderate length. The fresh beetles are decked with scales and hairs that make the beetles attractive looking, green, blue green, golden green, bronze, coppery. The weevils are harmful on fruit trees and young broad-leaved trees. The two commonest on rosaceous fruit trees are *P. oblongus* and *P. maculicornis*. Both are found now and again, in late spring and early summer, in impressive numbers. Some years ago *P. maculicornis* appeared in such masses on raspberry plants as to give rise in some places to a scare. Buds and leafage are destroyed; grafted plants suffer much.

The grubs feed in the soil at the roots of plants. The genus is rich in species and distinction is not always easy.

P. oblongus and *P. maculicornis*, which both measure about one-fifth inch, can be distinguished thus :—

> *P. oblongus*.—Wing-covers without scales, but showing a distinct long greyish pubescence; ground colour brown or black-brown; legs red; antennæ red with the clubbed apex darker.
>
> *P. maculicornis*.—Wing-covers with round scales, and with short erect hairs; legs black, covered, in fresh specimens, with greenish scales; antennæ yellow-red, but with the joints close to the clubbed apex dark.

Control of Otiorrhynchus and Phyllobius.—1. Shake the beetles down on to tarred boards or cloths; the beetles fall readily. In the case of Otiorrhynchus this should be done at night by aid of lantern; with Phyllobius it should be done in the early morning or on dull days.

2. In the south of England, where fruit trees are banded with a sticky preparation known as tanglefoot—this sticky substance is put on the stems to prevent the ascent into the trees of certain insect pests—large numbers of Otiorrhynchus and Phyllobius are caught.

3. Against Otiorrhynchus, sacking placed beside the food plants, or bands of hay twined in them, can be used as traps for the weevils, which will use them as shelter places during the day. The traps should be regularly visited and the sheltering beetles shaken out and destroyed.

4. In the case of wall trees, the walls should be kept well pointed so as not to provide hiding-places for the beetles. Otiorrhynchus cannot fly, and a band of tar along the base of the wall will prevent the beetles from ascending.

The Nut Weevil (*Balaninus nucum*).—This weevil, clothed in a golden-brown pubescence, measures about one-third inch; it has an impressively long and thin curved snout. The beetle is an enemy, in the south, of filberts, cob nuts and wild hazel nuts. The female bores a hole in the young nut by means of her snout (in weevils the jaws are at the tip of the snout or proboscis, the snout not being an elongated nose like the elephant's trunk, but an elongated head) and then introduces an egg. The grub (Fig. 3) feeds on the kernel, so destroying it. When full grown the grub gnaws a hole in the shell of the ruined nut (Fig. 4), and pressing its fat body with effort through the small hole drops to the ground for pupation or enters the soil directly from fallen nuts.

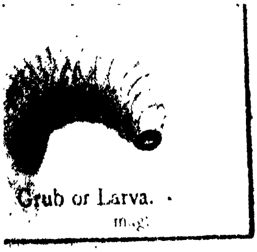

Fig. 3.—Magnified grub of the Nut Weevil.

Fig. 4.—Nut showing exit hole of full-fed grub.

Family Bruchidæ.

Leaving the weevils we come to a neighbouring Family, the Bruchidæ, sometimes confusingly and wrongly spoken of by the common name, pea and bean weevils. The beetles of the Bruchidæ family are thick-set, with rounded bodies and short square heads somewhat hidden under the front part of the thorax; the wing-covers are short and do not reach the end of the abdomen (Fig. 5). The larvæ are legless grubs (3 pairs of small legs are visible in newly hatched larvæ but disappear) with biting jaws; they live inside leguminous seeds.

The Pea Beetle (*Bruchus pisi*) and the **Bean Beetle** (*Bruchus rufimanus*) (Fig. 5).—These two beetles are very like one another; they measure about one-sixth inch long, are oblong-oval in shape, and black in ground colour with a brown-grey or brownish pubescence; the hind legs are longer than the others and have swollen thighs. On account of the shortness of the wing-covers the tip of the abdomen is exposed; in the pea beetle two distinct dark spots show through the greyish pubescence (use a lens) on this exposed tip, whereas the dark spots are faint in the bean beetle and may be absent. Further, as a distinction the thighs of the front legs of the bean beetle are red, while those in the pea beetle are black.

The life-history resembles in the two species. The females after pairing lay their eggs in the very young pods, entering the blossom for the purpose. The grub on hatching enters the seed, feeds on the reserve in the seed leaves, and on becoming full fed pupates at the place of feeding. The beetle after pupation has only to push its way out through a thin skin. Round holes (Fig. 6) mark the place of exit. Some of the beetles may issue in the autumn and pass the winter in some shelter place; or the beetles may issue in granaries and stores or shops; or remaining in the seed over the winter, they may issue when the peas or beans have been sown.

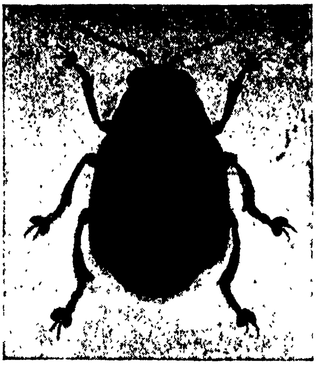
FIG. 5.
The Bean Beetle (*Bruchus rufimanus*).

FIG. 6.
The central figure shows one of the injured seed-leaves of the bean. The other two beans and the two peas show the hole by which the adult beetle has emerged.

Peas and beans are rich in reserve, containing an abundant supply in their seed leaves. Therefore if only one larva has been reared in the seed, and if the larva while feeding has confined itself to the seed-leaves and has not injured the plumule or radicle, then germination will be satisfactory. I have sown broad beans showing beetle exit holes up to five and six in number in order to test their germinative capacity, and I have been surprised at the plants which resulted. In some cases where the plumule failed to appear two shoots came above ground, from the buds in the axils of the two cotyledons or seed leaves. This does not mean that the plants were so good as in the normal germination of unharmed seeds.

According to the number of grubs that may have been reared in a seed will be the risk of poor germination and of resulting weaker plants. The risk will be greater in the smaller kinds of bean. There is always the risk too that millipedes and other small soil pests may gain entry to the seed, when it is sown, by means of the holes left by the escaped beetles.

There is a constant introduction from South Europe in the Seville and Aquadulce varieties of bean of another Bean Beetle, *Bruchus affinis*; indeed these beans are so much infested that I know seedsmen who regularly refuse them. When I desired Bruchus beetles for my practical classes I had only to buy Seville beans in the winter or early spring months to be assured of abundance of specimens. The warmth of the laboratory often brought the beetles out without dissection of the beans. Fryer, entomologist for the Ministry of Agriculture, considers there is little or no risk of *B. affinis* establishing itself with us because of climatic conditions. An American species, slightly smaller than our bean beetles, named Bruchus or *Mylabris obtectus*, is sometimes introduced in beans. This American Bruchus has the added danger that at home it also breeds and multiplies in stored beans that have previously been infested or which show wounds.

Control:—Infested seed should not be sown as this is just inviting attack on the new crop. The beetles present in the sown seed will issue and spend a free life in the open until the pods of the new crop are sufficiently advanced to receive the eggs of the beetles.

Fumigation is an excellent way of getting rid of the beetles in the peas and beans. There are two fumigants, viz. bisulphide of carbon (CS_2) and carbon-tetrachloride (CCl_4). The seed to be fumigated is placed in a container or receptacle which should be airtight. The carbon bisulphide, or the carbon-tetrachloride, is run into shallow basins or pans or saucers which are placed *on the top* of the seed to be treated. Both bisulphide of carbon and carbon-tatrachloride are liquids which vaporise or volatilise very readily, and the resulting vapour, which is at least twice as heavy as air, sinks down through the seed, and kills larvæ, pupæ and adult beetles. For 1,000 cubic feet of air space 5 lb. of bisulphide of carbon is used, and for carbon-tetrachloride 10 lb. per 1,000 cubic feet,—i.e. to say with a container or bin or receptacle of 50 cubic feet ¼ lb. of bisulphide of carbon would be used or ½ lb. of carbon-tetrachloride. The fumigation should last from a day and a half to 48 hours, after which the seed should be removed and spread out for airing. The temperature at which the fumigation is done is important; it should not be less than 60°F., and 70° to 75° is more favourable. This fumigation does not impair the germination of the seed, nor would it interfere with the use of the seed, if this were desired, for feeding purposes.

The vapour of bisulphide of carbon, and that of carbon-tetrachloride, is poisonous to human beings if they remain too long in its presence. Bisulphide of carbon is very inflammable and explosive if a naked light be brought near; the worker with it should not be smoking. Carbon-tetrachloride is not inflammable, but against this it is rather dearer and not quite such a sure killer.

A number of experiments have been done, and favourable results secured, in the destruction of insects affecting stored grain by subjecting the grain to temperatures of 120°F. and over for varying lengths of time. But heat is not recommended against *B. rufimanus* in broad beans. E. A. Back, the entomologist in charge of "Stored Products Insect Investigations" in the United States, says :—"Exposure to temperatures ranging from 120°F. to 140°F. for five to forty minutes did not kill this apparently more hardy insect, and the higher temperatures had an injurious effect upon germination.

We shall conclude our review of Beetles as insect pests in agriculture by looking briefly at the

FAMILY CHRYSOMELIDÆ OR LEAF BEETLES.

This is an enormous family characterised by antennæ of short or moderate length; the front of the head is not prolonged into a snout; and the upper surface of the body is not pubescent but is bare and often glossy. Most, both as adult and larva, feed on foliage and young green shoots. In this family come the Willow beetles, the Colorado beetle, the Asparagus beetle, the Mustard beetles and the Flea beetles or Turnip Flies of cruciferous crops.

Mustard Beetles.—These beetles have importance in south-east England where mustard is grown for seed. Two species may be named, *Phædon cochleariæ* and *P. armoraciæ;* they are very like one another, the first a little smaller than the other. Close comparison by aid of a lens brings out helpful differences.

P. armoraciæ measures from one-eighth to one-sixth inch; the wing-covers have prominent rounded shoulders with a distinct dent behind each; the upper side is dark blue, rarely greenish; the body is somewhat arched.

P. cochleariæ is barely so broad; the shoulders of the wing-covers are not prominent and there is no dent or impression; upper side dark blue, sometimes with a marked greenish shimmer.

The beetles pass the winter as adults in various shelter places, the favourite being in mustard stubble and straw. They come from their winter quarters in spring and feed on the leaves of the young plants. Eggs are laid on leaves in May and June, and the grubs on hatching also gnaw the foliage.

The larvæ are six-legged, jawed grubs, yellowish in colour, spotted with black, and with a row of gland-bearing tubercles down each side. The full grown larvæ pass into the soil for pupation, and a new brood of beetles comes away and these adults proceed to pairing and egg laying. When the numbers of this second brood are high, the plants suffer greatly from the feeding beetles and larvæ; stems as well as leaves are gnawed and seed may fail. The beetles resulting from the second brood of larvæ hibernate.

Flea Beetles.—These are small beetles which receive this name from their habit of springing or leaping away on being touched or disturbed. There is a considerable number of species of these closely related beetles, which attack crop plants and weeds of different orders. We hear most of the species which attack cruciferous plants—the so-called Turnip Fly is one of them—but there are other species whose favourite host plants are potatoes or mangolds, or hops or cereal crops like barley and oats.

Here we have only space to deal briefly with some of the commoner flea-beetle enemies of Cruciferæ.[1] Newton [1] names 14 Phyllotreta species and deals more or less fully with eight of them. Of these eight, six are feeders as larvæ on the roots of crucifers, one, viz. *Phyllotreta nemorum* as larva mines in the soft tissue of the leaf, and one *Phyllotreta vittula* is interesting because it attacks not only crucifer plants but gramineæ like oats, barley, rye, wheat, maize.

Certain general statements may be made about the flea beetles of crucifer crops, and important points emphasised.

I. The main damage is done by the adult beetles in three different ways and at three different times :—

> (1) The beetles come from their winter quarters in spring, and when the tender seedlings are breaking their way through the soil to the surface, the beetles, which may leave weed crucifers for the purpose, enter the cracking or breaking soil and attack the sprouting plants, which can be destroyed in numbers, especially if the tender part of the seedling, just below the appearing seed-leaves, be bitten. This means the seedlings are destroyed before they really show above ground.

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[1] There is some confusion in the literature as to species. The student who wishes to make a study of the subject, and to acquaint himself with recent experimental work, should consult the following Papers:—The Biology of Flea Beetles (Phyllotreta) attacking cultivated Cruciferæ and Experiments in the control of Flea Beetles of the genus Phyllotreta injurious to cultivated Cruciferous Crops, by H. C. F. Newton, B.Sc., in *The Journal of the S.E. Agricultural College*, Wye, Kent, 1928; also Observations on the Biology of some Flea Beetles of Economic Importance, by H. C. F. Newton, B.Sc., in *Journal of S.E. Agric. College*, Wye, Kent, 1929.

(2) The beetles that have over-wintered attack the seed-leaves and the above ground parts of the plants that have made some progress in germination. Many plants in this still tender stage are destroyed.

(3) Later the same over-wintered beetles attack the plants in the rough-leaved stage, and this attack is not very harmful and in some crucifers can be neglected. Newton says white turnip, among cultivated crucifers, suffers the worst damage because it is eaten also in the older stages.

(4) The new generation of beetles that come away in late summer eat the foliage of the now well-grown plants; the damage is not serious.

II. The larvæ or grubs feed at and on the roots, or in the case of *P. nemorum* (and perhaps sometimes *P. undulata*) mine the leaves. If the mines be numerous there is of course loss of feeding area and the tubers may be affected.

Phyllotreta nemorum, the so-called Turnip Fly.[1]—This beetle measures about one-tenth inch in length; down each wing-cover runs a yellow stripe or band which may be somewhat wavy; the middle region of the legs is reddish yellow.

The winter is passed by the adult beetles in such shelter places as under bark scales, in holes in trees, in rubbish heaps, in tufts of grass, among weeds, under fallen leaves, in the bottoms of hay stacks.

In spring these beetles come from their winter quarters and may feed for a time on crucifer weeds until the turnip or other cultivated crucifer is ready. The various types of damage at different stages in the plant's life have been detailed above.

The females lay their eggs in the soil or sometimes on the leaves of charlock, radish and other crucifers. The grub from the egg climbs up the stem, enters the rough leaf, and tunnels, for feeding purposes, in the fleshy part of the leaf, leaving behind it a trail of dark excrement.

The full fed grub measures one-quarter inch; in colour it is yellowish with the body showing a regular succession of dark horny plates; the head is dark and carries jawed and biting mouth-parts; there are three pairs of legs on the forebody and a muscular projection on the under surface of the last joint.

When full grown the grub leaves the leaf and enters the soil for pupation. As a rule with this species the pupa is found near the surface under cover of a little earthen cell. The pupal stage is soon passed, and the beetles come to the surface and pass to crucifer plants for feeding. The whole life cycle, egg, larva, pupa, adult beetle, is passed through in five to six weeks or a little longer, so that two, or perhaps more, generations occur. The beetles of the last generation feed for a time and then hibernate.

In his observations at Wye, Newton found the plants attacked by this beetle to be turnip, radish, charlock, black and white mustard, with a decided preference for radish among the cultivated crucifers. Newton never found *P. nemorum* on cabbage or swede in the field, but he bred the beetle through all its stages in the laboratory, on cabbage.

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[1] *Phyllotreta undulata* may be as common or commoner.

P. undulata is in some localities more common than *P. nemorum*, and is a general pest of cultivated crucifers. It is a little smaller than *P. nemorum;* the two yellow bands or lines on the wing-covers tend to curve inwards, and the middle region of the legs is black. The females lay their eggs in the soil and the larvæ feed on the roots. Pupation is in the soil under cover of an earthen cell. The length of a life cycle is roughly six weeks.

P. cruciferæ, P. atra, P. nigripes have life-history and habits resembling what has been described for *P. undulata*. The larvæ of these root-feeding species shun the light.

The Turnip Fly affords an interesting example of how conditions that favour the crop disfavour the insect, and *vice versa.* Thus turnip seedlings from seed with a good vitality of germination may be up, and the seed-leaf or smooth-leaf stage over, before the turnip flies are in great numbers. A good seedbed favours the plant; cloddy soil favours the beetle as offering shelter-places; land in good tilth even with only moderate moisture is in favour of the crop, whereas cloddy soil is against the plant by encouraging loss of moisture by evaporation; the weakened plants more readily fall before the beetle. Moisture favours the crop, the beetles prefer dry conditions. The beetles riot in sunshine—a hot spell in May may bring them in thousands; the plants drag in conditions of drought.

Control.—Practice such cultural operations as will favour the crop plant, including the clearing out of hedge bottoms and the destruction of refuse, so destroying winter shelter. Rolling also is of value.

Some protection from attack may be got by spreading on the drills deterrents like sand or sawdust steeped in paraffin.

Dressing the seed, before sowing, with paraffin or turpentine, " a dessert spoonful of either for 7 lb. of seed," is a practised measure concerning the efficacy of which there is considerable difference of opinion. Newton in his experiments found the method sometimes seemingly successful, at other times without satisfactory result. Jenkins[1] experimented in field and laboratory with a teacupful of paraffin or rather less turpentine to a pound of seed, care being taken that every seed should receive its share of the dressing. Not only did treated seed germinate in higher percentage, but infestation by the beetle was appreciably reduced. Conditions for success were that the seed after treatment should be allowed thoroughly to dry and be drilled at once after drying.

Trap the beetles when they are at work on the plant by taking advantage of their fondness for sunshine and their leaping habit when disturbed, thus :—Fix a light wide framework on wheels supporting well-tarred boards, the tar on the under side; arrange that the boards are just over the plants; push this up and down the field. Hundreds of beetles may be caught if the boards are kept well tarred. There are numerous patterns of such traps concerning which Newton says:—(1) "They must be lightly made so as to be easily worked by a man or boy and as wide as possible without becoming unwieldy; (2) they must be pushed, not drawn; (3) they should be used when the beetles are most active in the warmer part of the day; (4) the surface of the land should be as level and free from clods as possible."

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[1] **Seed treatment as a means of preventing Turnip Flea Beetle Attack, by J. R. W. Jenkins in the *Welsh Journal of Agriculture*, 1928.**

Spraying.—Paraffin emulsion, paraffin 2 pints, soft soap 1 lb., water 10 gallons, is often used as a deterrent spray. Newton as a result of his experiments found it inferior to a nicotine sulphate spray, 0·2 to 0·5 per cent. of nicotine sulphate content with free soft soap in solution at the rate of 4·5 lb. per 100 gallons. The nicotine sulphate, sprayed twice or three times at four days interval, gives protection in the earliest stages of attack.

DEMONSTRATION POULTRY CROFT AT MACHRIE BAY, ARRAN.

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ALTHOUGH poultry keeping is generally considered a very suitable side-line in the management of a small-holding, it occupied only a very minor position in the husbandry of Arran small-holders until recently. While in a few instances flocks of pure-bred birds of good laying strains were kept, the stocks on many of the holdings were of more or less nondescript type and doubtful age and received but little attention. Under such conditions it is not surprising to learn that the concensus of opinion among the small-holders was that every hen died in debt, and apart from the fact that they provided a very useful commodity for the household commissariat and were able to make use of scrap food, they were of very little value. Poultry keeping for profit was deemed a snare and a delusion.

The reasons for this outlook are not difficult to understand. During the summer months, when eggs were naturally plentiful, there was a good demand for them by visitors to the island. No local demand existed during the winter, and owing to the difficulty of obtaining eggs from the stock kept in sufficient quantity to justify the work and expense entailed in their shipment to a suitable market on the mainland, the poultry during this season got scant attention or consideration.

Establishment of Croft.—In the autumn of 1927 it was agreed to establish a Demonstration Poultry Croft on the island in an endeavour to show that by proper selection of stock and careful management, poultry keeping could be made a paying proposition even under the prevailing conditions of a seasonal local demand, high freights on feeding stuffs, and relatively high marketing costs for produce during the winter months. Some difficulty was experienced in securing the co-operation of a small-holder who was willing to undertake the work of the poultry croft and would be likely to give the undertaking the attention necessary to make it a success, but in February 1928 it was agreed to establish the Demonstration Croft on a holding at Machrie. This croft, situated near the southern point of Machrie Bay, has a north-westerly exposure. No shelter exists from this direction and there is practically none from the north or north-east. The ground where the poultry are run is fairly level and is of a light, dry, sandy nature.

General Management.—About 50 head of poultry were kept on this holding when the croft was established, but these were removed to an adjoining croft and disposed of as opportunity arose. A Glevum incubator (capacity 150 eggs) was purchased and set twice with White Wyandotte eggs bought from the Poultry School, Kilmarnock. In the first season 160 birds were reared, of which 82 were cockerels and the remaining 78 pullets. As soon as the pullets could be distinguished they were segregated from the cockerels. The method of fattening the cockerels for disposal as table birds and the subsequent management of the pullets is detailed in the section dealing with feeding. The birds were not allowed to roost until they were from 10 to 12 weeks old. By taking this precaution the common defect of crooked breastbones was obviated except in one or two cases.

No difficulty has been experienced in selling the eggs or table birds locally during the summer, and during the winter the eggs have been regularly sent to retailers in the Glasgow district at prices which have proved quite remunerative. A similar system of rearing and disposal of surplus stock and produce has been practised since the establishment of the croft.

At the beginning of 1929 there were no two year old birds on the premises from which hatching eggs would normally have been obtained, and a selection was made of the best and strongest pullets which had commenced to lay early, had undergone a pullet moult and were rested. These birds were mated to a two year old cock of good type and strain which had been purchased, and the eggs from this pen were used for hatching with very good results. In the following year (1930) the hatching eggs were obtained from two year old birds mated with bought in cockerels.

Feeding.—In the details of the rations fed to the various classes of stock, which are given below, it will be noted that expensive and elaborate mixtures have been avoided. When it is remembered that the primary object of the croft was to show that poultry, if well bred, suitably housed and properly fed could be made a profitable side-line for the small-holder, the advisability of feeding mixtures composed of grains and meals in common use on the farm is obvious. It has been found that a combination of wet and dry feeding has given the most satisfactory results throughout.

Chickens.—Care is always taken not to feed the young birds too soon, the first meal being given when the chicks are from 36 to 48 hours old. They are allowed access to fine grit from the time of hatching in order to assist in the proper assimilation of the yolk, which has been absorbed by the digestive system before the bird emerged from the shell, and of all food subsequently given. During the first fortnight feeding is done every two hours, " a little and often " being found to give the best results. Grain and mash are fed alternately, part of the mash being fed wet and the remaining portion given in the dry state.

From the third until the end of the eighth week five meals per day are given, the number being reduced to four per day from the eighth to the twelfth week.

During the first few weeks a liberal supply of green food, chopped finely and added to the mash, is always given to the birds. Grit is likewise always available. As a drink, water only is given for the first few days, and this is gradually replaced by soured milk or buttermilk. The addition of cod liver oil to the food has always shown beneficial results, especially in the earlier part of the season.

When about 12 weeks old, the pullets, separated from the cockerels, are put on free range in portable colony houses and fed on a ration of growth-promoting food. Care is exercised not to force the birds too quickly at this stage so that they are well developed and matured before coming into lay. As a result the number of second grade eggs produced is surprisingly low.

At 4½ months the pullets are removed to the laying house, which on this croft is a permanent stone building. The growing ration is replaced by a more stimulating mixture, bringing the birds into lay when 5½ to 6 months old.

When separated from the pullets, the cockerels are housed semi-intensively or pen fattened for three weeks before being sold. During this period they are fed twice daily on the fattening ration given in the tables below. The meals given are mixed to a thin creamy porridge with sour milk about 24 hours before feeding and fed in a thick porridgy condition. If sour milk is not available a quarter part of meat meal or fish meal is added and the porridge made with water. No definite weight of food is allowed, the birds being given as much as they will consume in 20 to 30 minutes at each feed. The increase in weight produced during this period varies from 1 to 2½ lb. per head.

Laying Stock.—All the laying stock are on free range and a similar system of wet and dry feeding is practised. Grain is given in the morning, dry mash *ad lib.* during the day, with a wet mash at night. During the winter a small quantity of grain is fed before the birds go to roost. The average consumpt of food is approximately 2 oz. grain and 2 oz. mash per bird per day with, of course, grit and green food in addition. It may also be mentioned that when any milk can be spared from the household this is given to the poultry. At other times they must content themselves with water.

Rations.

Mash Mixtures.

No. 1. *1st week.*

1 hard boiled egg (2 oz.) to 4 oz. oatmeal.
1 oz. floury thirds.
Chopped greenfood added.

No. 2. *2nd to 4th week.*

4 parts (by weight) biscuit meal (scalded).
4 parts oatmeal.
4 parts thirds.
2 parts bran.
1 part maize meal.
¼ part fish meal.

No. 3. *5th to 8th week.*

3 parts bran.
5 parts thirds.
3 parts crushed oats.
2 parts maize meal.
½ part fish meal.

9th week-4½ months.

Growers' Mash (Pullets).

6 parts bran.
8 parts thirds.
3 parts crushed oats.
3 parts maize meal.
½ part meat or bone meal.

Layers' Mash.

4 parts bran.
4 parts thirds.
3 parts maize meal.
3 parts crushed oats.
1 part meat meal or fish meal.

Grain Mixtures.

No. 1.

6 parts kibbled wheat.
5 parts kibbled maize.
4 parts pinhead oatmeal.
1 part canary seed.

No. 2.

3 parts small wheat.
2 parts kibbled maize.
1 part oats.

No. 3.

1 part oats.
1 part maize.
1 part wheat.

Fattening Ration (Cockerels).

1 part oatmeal.
1 part crushed oats.
1 part maize meal.
¼ part fish or meat meal.

Grain.

1 part oats.
1 part maize.
1 part wheat.

During the summer months the quantities of maize meal and meat meal in the layers' mash are reduced by a half.

It is unfortunate that space will not permit the inclusion of the accounts of the holding in the present article, but it is hoped that these will shortly be published in the form of a College Bulletin. A full statement of the cost of rearing the pullets in the first year of the croft is appended, however, as no complications arose at that time through other poultry stock being fed on the holding. The annual balance is drawn up on 30th September each year, and at that date in 1929, allowing for depreciation on all houses and appliances for the period from

February 1928, the profit shown by the 78 hens on the holding was £112, 11*s*. 11*d*. or £1, 8*s*. 10*d*. per bird. This figure does not include any charge for labour or for the use of the land on which the birds had free range. When an allowance of 10*s*. per week for labour is made for the period from February-September 1928 and 15*s*. per week from that date till September 1929, and £4 allowed as rent of the land, which incidentally was not occupied by the poultry alone but was grazed with cattle and sheep, the net profit is £52, 11*s*. 11*d*. or 13*s*. 6*d*. per hen.

The number of eggs laid per bird during the year October 1928-September 1929 amounted to 168, while the average price obtained for these, exclusive of a few sittings sold at a higher rate, was 1*s*. 11*d*. per dozen.

Cost of rearing White Wyandotte Pullets, February-September 1928.

Expenditure.		
24½ doz. eggs for setting		£7 2 0
Paraffin oil		0 18 5
Depreciation on brooder and incubator		1 2 10
Feeding stuffs		24 10 3
		£33 13 6
Allowance for labour, 34 weeks at 10*s*.		17 0 0
Allowance for rent of land		1 0 0
Total cost		£51 13 6
Deduct.		
Sum realised for sale of 80 cockerels	£17 0 6	
Value of one stock cockerel retained	0 10 0	
		17 10 6
Actual cost of 78 pullets at 30th September 1928		£34 3 0
Cost per pullet	£0 8 9	

The returns for the year 1929-1930, although scarcely so good as the previous year, still showed a fairly good profit.

Sixty-nine hens and 80 pullets were kept, and the gross profit over the year amounted to £105, 4*s*. 0½*d*. or 14*s*. 1½*d*. per bird. Again making the ample allowance of 15*s*. per week for labour and £4 for rent, a clear net profit remains of £62, 4*s*. or 8*s*. 5*d*. per bird.

During the year the average egg production of the pullets was 172. The average egg production for the year of the two year old hens cannot be given, as most of these birds were disposed of during July and August in order to take advantage of the local demand for table birds at that time. The average price obtained for the eggs during this year was lower than that previously obtained, being only 1*s*. 9½*d*. per dozen.

Since its inception, keen interest in the proceedings at the croft has been evinced by most of the small-holders in the neighbourhood. A public demonstration was held after the returns had been obtained over a full year's working and this was attended by small-holders and farmers from various parts of the island. The general management of the holding was outlined and a demonstration given on the preparation of fowls for table use. Numerous questions about rearing, feeding and the selection of good laying birds were also dealt with. The balance sheet of the croft which was available for inspection created a good deal of interest, and an inspection of the poultry and houses on the holding was made by those present. Subsequent demonstrations have been arranged when matters relating to the care of poultry in general, prevention and treatment of various diseases and other phases of poultry husbandry have been freely discussed and a demonstration given in the method of taking blood samples for testing bacillary white diarrhœa.

The work which has been carried out at this croft has undoubtedly led to a much greater interest being taken in poultry by the small-holders—not in the immediate vicinity of the croft alone, but throughout the entire island. This is reflected not only in the greater number of poultry kept, as evidenced by the increasing number of poultry houses, but in the improved class of birds now kept on most of the holdings.

COLOUR INHERITANCE IN SWEDES AND TURNIPS AND ITS BEARING ON THE IDENTIFICATION OF COMMERCIAL STOCKS.

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In many crops it is possible to attain a high degree of uniformity in various colour characters. A slight difference of colouring in a sample of oats or potatoes, for instance, would be sufficient to raise doubt as to the purity of the strain. Every tuber of a potato variety is a piece of one individual plant which has been multiplied to an enormous extent by separation of vegetative parts, and variation consequently should be practically non-existent. Again an entire variety of oats may be descended from one true-breeding grain, and in this case the natural disposition to self-fertilisation protects the strain from contamination from outside. Such strictness is of course impossible when dealing with varieties of root crops since these show great variability in their characters, due in part to the method of propagation. In root crops such as the turnip (*Brassica Rapa* L.) and swede (*B. Napus* var. *Napobrassica* (L) Peterm.) cross-fertilisation is general. Originated from a group of plants not precisely alike in hereditary constitution, and propagated by a selected group in each generation, a "variety" contains a heterogeneous collection of hereditary factors, continually being shuffled by crossing, with the result that characters are sometimes obscured and sometimes displayed. Still, even in these species uniformity is expected in respect of some colour characters. For instance there should be only one colour of flesh, so that the appearance of a white-fleshed individual in a yellow-fleshed crop, or *vice versa*, would be a suspicious circumstance, and might even be a warning that hybridisation by swede-like rape had occurred; a difference in flower colour would also have an important bearing in this respect. On the other hand, the skin colour of a variety of swede, particularly of a bronze-top, may vary from plant to plant, while the general tendency may not be the same in different years, or at different times during the growing season. Some of this variability might be reduced if desired, but for the most part it is unavoidable and raises no question as to the purity of the stock.

Plants with obviously different skin colours occur in some varieties, both of swede and turnip. These are sometimes due to admixture of seed and sometimes to hereditary recombinations within the strain. For instance, though certain varieties of purple-top swede are quite uniform for the purple character, others show a small percentage of bronze-top plants. These latter in other respects conform to the varietal type, and their occurrence is not due to admixture of seed during recent generations. White-skinned turnips in a red turnip variety afford a similar instance. On the other hand rogue plants of some other variety are sometimes found in a crop, while occasionally obvious hybrids occur as the result of a natural crossing with plants of other strains.

It is proposed to discuss some examples of uniformity and variability and to describe the manner of inheritance of certain colours, so that their relation to varietal types may be elucidated.

I. Flesh Colour.—The main colouring of the interior parts of the bulb, both in turnip and swede, is either white or yellow. The yellow colour is not due to a solution in the sap, but is borne on small bodies called plastids which occur in the minute cells forming the plant structure. The hereditary causes or factors governing the production of this colour afford a clear cut difference between the yellows and whites, and the environment, i.e. the weather and other outside forces, does not modify these colours to any noticeable extent. It is probable, however, that there are minor hereditary factors governing the intensity of the yellow fleshed condition.

When yellow and white turnip plants are crossed, irrespective of which is the mother plant, the (F_1) hybrid offspring are all white fleshed and indistinguishable from the true white turnip. If these hybrids are seeded by themselves, or if one of them is made to set seed in a pollen-proof bag, a second (F_2) hybrid generation is obtained in which flesh colours of both parent stocks appear. Moreover the proportions in which they do so can be foretold—viz. 3 white to 1 yellow, provided that a sufficiently large number of plants is examined so that errors due to chance groups of one or other colour become nullified. This behaviour is merely in accordance with the Mendelian law of inheritance.

The point to be considered here is that the yellow constituent plants of the F_2 generation can produce only offspring having that flesh colour, and hence any strain which may be raised from them will be true breeding for yellow flesh. The white constituents on the other hand are of two kinds, though outwardly indistinguishable. Some of them—approximately one-third—have a pair of hereditary factors for white flesh like the original white parent, and they will breed true for white flesh, because no factor for yellow flesh has entered into their hereditary constitution. (It should be mentioned that hereditary characters are represented in a plant's constitution by pairs of factors one of which is derived from each parent.) The other two-thirds of the white F_2 plants have hereditary constitutions like the first (F_1) hybrid generation, i.e. they contain one factor for white, which determines their visible colour, while the other factor of the pair should produce yellow, but its action is masked by the white; such a plant cannot breed true and will throw a proportion of yellows in the following generation. The introduction of unlike factors into a plant has no blending effect, i.e. a factor which governed yellow prior to its entry into a hybrid plant will be transmitted to that plant's offspring still producing yellow and not modified by its contact with the factor for white.

The sequel to a white × yellow fleshed cross is that it is easy to breed yellow strains from the descendants but harder to obtain true-breeding white-fleshed strains. The only effective manner in which the latter can be fixed is to self-fertilise single plants for a generation or two, and thus to make sure that no yellows are appearing before multiplying the strain. Attempts to purify a strain which is being seeded in mass each generation by the removal of yellow individuals must necessarily be ineffective, since white plants of the F_1 hybrid type will remain in the stock.

In the early days of swede cultivation white-fleshed varieties were extensively employed, but we are informed by Pringle (Ref. No. 5) that the colour was associated with poor shape and fang-like roots which were also true-breeding, and so could not be improved by selection, hence these stocks dropped out of cultivation. It is not essential, however, that white flesh should be associated with fang-like roots in the swede, for certain strains at the Scottish Plant Breeding Station are of good shape. Moreover, there are white-fleshed varieties in use on the Continent and in Canada.

One reason why the white-fleshed swede fell into disuse may have been the difficulty in detecting hybridisation by swede-like rape (*Brassica Napus* L. var *arvensis* Hegi.), a species closely related to both white and yellow swede. Swede-like rape has a thick, but bulbless, woody and fang-like root of white colour, while hybrids between it and swede are quite fertile and have small, white-fleshed, fanged bulbs of intermediate woodiness. Such plants are detrimental to the crop and must be strictly excluded. Lafferty (4) has shown that the " bulbless bolter " rogue plants, which sometimes occur in a swede crop in considerable numbers, are either rape plants from admixed seed, or else hybrids due to fertilisation of swedes by the pollen of rape. This view is supported by observations at the Scottish Plant Breeding Station. It will be noted that whereas the presence of rape adulteration may easily be detected in yellow-fleshed swede crops by the flesh colour, and, as will be mentioned later, by the flower colour also, yet it would be more difficult to detect such contamination in a white-fleshed variety, especially if the strain were exhibiting the somewhat fanged and misshapen forms frequently attributed to this type.

The flesh colour inheritance of swedes is slightly more complicated than is the case in turnips, because the factor pairs are duplicated. Thus there are two distinct but similar pairs of factors, each of which is capable of producing white-fleshed colour, even when several factors for yellow are present. Certain white-fleshed varieties which have been examined at this Station, or in Sweden (2) (1), have been found to contain both factor pairs breeding true for the white condition, and the same is true of some at least of the swede-like rape strains. When a white-fleshed plant of this nature is crossed with a yellow-fleshed swede the (F_1) hybrid progeny are all white-fleshed. If these hybrids are self-fertilised or crossed with one another a second (F_2) hybrid generation is obtained, in which the proportions are 15 white to 1 yellow-flesh. This happens because chance combinations determine that 15 out of 16 plants shall contain at least one factor for white; while the sixteenth has none of the factors for white, and is consequently yellow, and will breed true for that colour. The white-fleshed plants of this generation are of several kinds. Some contain only one factor for white (the other three being for yellow), and these will throw both white and yellow offspring. Others contain two factors for white, one of either pair, and these too will have progenies of mixed type. Others again contain one or both pairs of factors for white, and these breed true for white flesh. It should be mentioned in passing that the flesh of a suspected plant when being tested should be notched deeply since the bark of a yellow swede is white in the region immediately beneath the skin pigments.

The swede and the turnip are capable of hybridising, but the economic danger of such an event is diminished for several reasons. The actual hybrids have large and good bulbs, they are readily recognised by their mongrel shaw characters, and they are nearly always marked by great development of nodules and swellings resembling finger-and-toe disease, which alone should ensure their rejection from breeding stocks. If retained for seeding, however, the hybrids themselves would give practically no seed, but by natural crossing with the surrounding crop plants some seed might set, which would give rise to plants of inferior type. Where swede × turnip crosses have been tried experimentally (Ref. No. 3 and at this Station) it has been found that the factor for white in turnip has the effect of masking the yellow of the swede, while conversely the white swede factors dominate and mask the yellow of the turnip. In other words the hereditary causes governing flesh colour in both turnip and swede are very similar, though more complicated in the latter species.

II. Flower Colour.—Although at first sight the flower colour of a root crop may appear to be quite irrelevant, yet it is actually of considerable importance in keeping stocks true to type and in guarding against the introduction of rape. This is more particularly the case during the multiplication of the stock seed, when the sowing is in autumn, and the plants grow rapidly during the following spring with practically no bulb formation. The flower colour then gives a visible indication of the flesh colour, because the two characters are controlled either by the same hereditary factor or by very closely connected hereditary causes. The yellow colour of the petals is due to the pigmentation of plastids similar to those in the flesh; hence the same factor may affect the colour in both parts of the plant.

In swede the white-fleshed plants have bright lemon yellow petals, while yellow-fleshed plants have petals coloured dull or matt, buff yellow (Naples yellow). In turnip the flower colour of the white-fleshed variety is almost identical with that of the white-fleshed swede, i.e. bright lemon yellow; while the yellow turnip has a matt buff yellow petal, which is, however, more chalky in appearance than its counterpart in swede. Four tints of yellow flower colour have been described (Sylven (6)) in rape, but the varieties commonly grown in this country resemble the bright lemon yellow flower of the white-fleshed swede. It is thus possible when examining a flowering crop of yellow-fleshed swede to detect by their brighter and more yellow flower colour any plants of white turnip, white-fleshed swede, swede-like rape or any of their first generation hybrids.

III. Skin Colour.—The skin coloration of swedes and turnips is due to the presence of one or more of four components: (1) a green colour borne on a certain type of plastid, and identical to that which colours foliage, &c.; (2) a red pigment not associated with plastids, but dissolved in the cell sap; (3) the colour of the underlying flesh, which, in turnip, may show through when red and green pigments are absent, and which is also responsible for the colour of underground parts; (4) the presence or absence of particles of dead tissue forming a "scurf" over the surface of the skin.

The turnip, in absence of both green and red characters, has a somewhat transparent skin, appearing yellow or white according to the underlying tissue, but the ability to produce at least traces of colour is apparently not lacking in any turnip, and under certain environmental conditions flushes of faint red colour or tinges of green, or both, may appear in patches on the above-ground portions of the otherwise colourless bulb. The presence or absence of these tinges is believed to be controlled entirely by environment and not by heredity, because plants of extreme types do not impart these extremes to their offspring. The strongest red or green tinges are distinctly less coloured than the true red or green-skinned plants, so that there is no question of confusing them; it will be seen, however, that the absence of skin colours is not absolute, but only relative.

The green-skinned turnip has the whole of its above-ground parts covered uniformly with green. If a true-breeding green is crossed with a non-green (e.g. a yellow), the (F_1) hybrid offspring are all green. These, when self-fertilised or crossed among themselves, give rise to a second (F_2) generation in which the proportions approximate 3 green to 1 non-green. The non-green plants would breed true in respect of that character, while among the green-skinned constituents some would breed true and the rest would have mixed progenies.

The red colour in turnip is a well defined character, the whole of the above-ground skin of the bulb being uniformly coloured. The same simple type of inheritance occurs here also, for red plants when crossed with white or yellow skinned plants give hybrid progenies all red in skin colour. There is reason to believe, however, that the coloration in these is not so intense as in the true-breeding red parent type. In appearance the hybrids look less bright, but the red is evenly distributed over the whole surface, and is quite distinct from the flush on the non-red type. The (F_2) second hybrid generation segregates the two colours in the proportions of 3 red to 1 non-red, and though the slight difference mentioned above can be observed among the red-skinned members, yet they are not sufficiently distinct to determine with certainty which plants are true-breeding and which are liable, like the F_1 hybrid, to segregate both colours. The intensity of the red colour is to some extent affected by environment.

The actions of red and green characters are entirely independent of one another. When red and green are both present in the same plant the effect is known as " purple." The red colour is contained in the sap of the superficial cells and the green is in the cells just beneath; thus it is possible to expose the green by scratching the red off the surface. The red, which verges towards mauve, in conjunction with the green beneath appears as an impure reddish purple.

If a purple (red and green) plant is crossed with one which is red without green, the red remains true breeding throughout the hybrid generations, the (F_1) hybrid generation is purple on account of the green present, and the (F_2) second hybrid generation segregates in the proportions 3 purple (red and green) to 1 red with no green. The same kind of green tinge which occurs on the white skin might occur here, but it would be difficult to discern it through the red pigment.

If a purple (green and red) plant is crossed with a green plant, the green which is present in both parents will remain true breeding in the hybrid generations. The F_1 hybrid will be purple and the (F_2) second hybrid generation will present both types in the proportions 3 purple to 1 green. Here, likewise, the green plant might show a flush of red.

If a true breeding purple plant is crossed with a white skinned plant the F_1 progeny are purple; while in the second hybrid generation four colours emerge in the proportions, 9 purple, 3 red, 3 green, 1 white. This is merely a combination of the segregating activities of both red and green.

If a true breeding red plant is crossed with a true breeding green, the first hybrid generation will consist of purples, since a colour has been inherited from each parent. The second hybrid generation presents the same type of segregation as the last example, viz. 9 purple, 3 red, 3 green, 1 white.

The inheritance of white and yellow flesh colour is entirely independent of the various skin colours, so that similar complex ratios would occur if these characters were included in a hybridisation.

Another skin colour character which occurs in turnip is the "tricolour" effect due to the limiting of the area of red colour to leave a band of green round the middle of the bulb above ground level. Hereditary factors which limit or extend an area of colour are common in plants. There is also a skin type which consists of a mottling of purple colour, i.e. the "greystone." The inheritance of this, and of the "tricolour" in relation to the colour series described above, has not yet been investigated.

Skin colour in Swedes.—In swedes the green pigment uniformly covering the bulb is a true-breeding character, and white or yellow skinned varieties are not found on the agricultural market, while rogues of this nature rarely if ever occur. Nevertheless, Vilmorin (7) in 1891 described varieties of swedes which apparently resembled the white and yellow skinned turnips in having only tinges of green on the surface of their tops.

The red colouring of all types of swede appears to be of the same tone, vinous-mauve, but concentrated to different degrees. As in turnips it is restricted to the superficial layer of cells and lies externally to the green. The red colour is sometimes clear, but different amounts of "scurf" often greatly affect the appearance. In the main the amount of "scurf" seems to increase with the firmness of flesh and lateness of maturity of the strain. Thus the soft-fleshed early purple-tops have more or less clear skins and bright colour, while the hardiest types, green-tops as well as purple-tops, are generally thickly covered with "scurf."

The variation of the red coloration in swedes is so great that it is not easy to make well defined sub-divisions. In general practice swedes are classed according to colour as purple-tops, bronze-tops and green-tops; yet though there may be no doubt as to the character of the crop as a whole, it may often be difficult to determine whether certain individuals are purple or bronze tops. It is still less certain whether a plant is hereditarily a green-top or a light bronze-top. The green-top varieties themselves share a number of shape and shaw characters which point to close relationship amongst them, but with regard to colour, they may develop a faint tinge of red pigment on their bulbs in certain seasons, and their buds are frequently red. In other seasons red colouring may be slow to develop, so that light-bronze strains look as though they too were devoid of red.

In 1913, Kajanus (2) attempted to determine the Mendelian hereditary factors governing the three colour classes of swedes. It may here be explained that most of the turnip characters discussed above were first investigated by Kajanus (2) (3) or his collaborator Hallqvist (1), the crossings being repeated recently at the Scottish Plant Breeding Station. Kajanus found that " red " (purple-top) acted as an alternative character to " red-green " (bronze-top) and to " green." The F_1 hybrids of such a cross were all " red," and the second hybrid generation gave the ratio 3 " red " to 1 " red-green " or " green." The figures were not very exact, however, and there were some doubtful plants. He also obtained figures suggesting that " red-green " and " green " were in some cases alternative characters, but later he decided to abandon these as not precise enough. The difficulty lies not in the absence of hereditary factors, for there is plenty of evidence that these exist, but in the masking effect of environmental modification. This is especially marked in the bronze-top strains, which vary greatly in appearance from season to season. In some cases the south side may be as strongly coloured as a purple-top while the north is almost green. The development of colour is evidently dependent to a large extent upon the amount of light which penetrates the foliage and reaches the " bulb." Thus not only is the southern side more strongly pigmented, but when a plant is growing in an open space, or when a shaw has been disarranged, the colouring is still more intense. The process is thus comparable to the printing of a photograph.

Another source of variability in the characters of swedes is their method of propagation. Frequent cross-fertilisation causes the hereditary differences in constitution which may exist within a breeding stock to be shuffled periodically and dealt out to individual plants in different combinations. In the turnip an instance of this has been quoted above in the appearance of distinctly different colours, but in the swede, where there are several sets of hereditary factors all acting on the production or distribution of red colour, it might be impossible to distinguish between some of the different hereditary combinations, even if these were not also intensified or diluted by environmental modifications. The overlapping of types is so great that an almost continuous series of red intensities from complete absence in a green-top to very deep purple could be constructed.

At the Scottish Plant Breeding Station a large number of skin colour types have been selected from different varieties of swede and tested by examination of progenies from single plants for one or more generations. Comparison of plants of a commercial variety by these methods gives interesting results, some of which may be outlined as follows :—

(1) The difference between the skin colour of two selections from a variety may disappear in their progenies, showing that one at least of the original plants had been modified by environment.

(2) The difference between the skin colours of two selections may be maintained between their offspring in successive generations, showing that hereditary variations had existed in the original plants. Thus two purple-tops were selected out of one variety because they showed a difference in intensity of pigmentation. Lines were bred from each for four generations, and the difference in intensity was noted throughout. Again, a light and a dark bronze-top were chosen from a variety which generally contains a range of intensities. Plots of the descendants have been grown side by side for four generations, and although the pigmentation of both types gets progressively stronger during the growing period, and although the actual intensities vary in different seasons, yet it has been possible each autumn to note the relative differences between strains.

(3) The immediate effect of self-fertilisation is generally a reduction of the variability, the progeny being uniform in skin colour, or varying only slightly.

(4) Occasionally a plant may have a mixed progeny; thus purple-tops have not infrequently been chosen, the progenies of which segregated in the proportions 3 purple to 1 bronze top.

One outcome of this work has been to suggest to the writer that the classification of Kajanus (2) needs slight modification. The amount of colour on both top and neck is not a good guide as to the character. The presence of the chief Mendelian factor seems best to be determined by the colour of the neck; if the surface between leaf scars is uniformly red or red-purple with no green areas, then the plant is a true purple-top; if the neck is green or mottled purple with green areas, the purple-top producing factor is absent and the plant is bronze or green. The necessity for this distinction lies in the fact that bronze-tops occasionally colour strongly and look quite purple, the neck being the last place to show the green. It can be ascertained from their progenies that such plants are really bronze-tops. On the other hand some plants, especially in second hybrid generations between purple × green top, have purple necks and little or no purple on the "top," and these can be shown to have had the factor for purple. It seems that the expression of the most distinct purple-giving factor is primarily seated in the neck region. The purple colour is normally extended downwards over the whole of the " top " either entirely covering it or leaving a thin or even a wide band of green at ground level. The width of the band is due to other causes. Evidence supporting this conception is also afforded by the F_1 hybrid of the cross between purple × non-purple swedes. Such a plant has a true purple neck but the band of green at the ground level is wide, and the colour on the top is so dilute that the underlying green shows through, giving a brownish red instead of a clear vinous-mauve appearance. The factor for " purple-neck," as it may be called, also extends the red colour into the leaf stalks, provided that other conditions are favourable. This is suggested by the fact that, while purple-tops may or may not have strong colouring in the shaw, bronze and green tops show very little or none. If the factors governing colour in the shaw were independent of the factors for purple-neck, all classes of swede should sometimes show plants with strongly coloured shaws.

Hereditary Characters.

	Parents.	Hybrid.	Proportions found in Second hybrid generation.
Flesh Colour—			
Turnip ...	White × yellow.	White.	3 white, 1 yellow.
Swede ...	White × yellow.	White.	15 white, 1 yellow. 3 white, 1 yellow.
Skin Colour—			
Turnip ...	Green × white.	Green.	3 green, 1 white.
Do. ..	Red × white.	Red.	3 red, 1 white.
Do. ...	Purple × red.	Purple.	3 purple, 1 red.
Do. ...	Purple × green.	Purple.	3 purple, 1 green.
Do. ...	Purple × white.	Purple.	9 purple, 3 red, 3 green, 1 white.
Do. ...	Red × green.	Purple.	9 purple, 3 red, 3 green, 1 white.
Swede ...	Purple-neck × bronze-top.	Purple-neck.	3 purple-neck, 1 bronze-top.
Do. ...	Purple-neck × green-top.	Purple-neck.	3 purple-neck, 1 bronze or green top.
Do. ...	Purple-neck × Purple-neck (white and yellow-fleshed strains).	Purple-neck.	15 purple-neck, 1 bronze-top.

It seems certain that other hereditary factors, probably including those which differentiate between bronze and green, play a part in intensifying the skin and neck colours of different types of purple-top.

The hereditary factors governing the production of red colour in bronze-tops are still less precise in their effects. Examination of self-fertilised lines shows that there are at least three true-breeding combinations, i.e. green, light-bronze and dark-bronze; in addition, the existence of a fourth type in which the bulb is almost purple and the neck green only on the north side has also been established. The red colour is concentrated chiefly in the colouring of the top round the " shoulder " and extends down towards ground level, but usually fades into a wide band of green. The neck is usually green, but the red sometimes extends into this region in patches. The shaw and young leaves are generally devoid of red, but sometimes the latter are tinged, while very occasionally there is faint colour in the leaf stalks. The red pigment is generally more dilute than in the purple-top, and the general effect is a mottling of mauve and green in bands, the mauve areas being speckled with green spots. The southern side when strongly coloured becomes uniformly vinous-mauve.

Another point may be mentioned here because it illustrates the unexpected results which may follow hybridisation within a species. It has already been seen that the swede has a duplicated set of factors governing white flesh. It has lately been found, by the present writer, that a duplicated set of factors governing the purple-top character also exists. In a cross intended to test flesh-colour inheritance, a white-fleshed swede was crossed with a yellow-fleshed plant of a commonly grown variety. Both parent bulbs were true breeding for their purple neck characters. As was to be expected the F_1 hybrids were all purple-necked plants. In the F_2 second hybrid generations, however, approximately one-sixteenth of the plants were bronze-tops. This was confirmed by a second cross of the same nature. The explanation of this behaviour is that the factors which produced the purple-top condition in the two parent plants were essentially different, though similar in the character they produced. In the F_1 hybrid generation a factor for purple-neck had been inherited from each parent, so that these plants were purple-tops. In the second hybrid generation 15 out of the 16 plants inherited one or the other or both types of factor for purple-neck, and were consequently purple-tops. The sixteenth plant, however, failed to inherit either factor for purple, and therefore showed whatever colour it was capable of producing, i.e. bronze.

Admixture of Colours in Samples of a Variety.

Crop.	Aberrant colour which may be retained hidden in mass-selected strain.	Aberrant colour due to admixture of seed or crossing from outside.
White-fleshed turnip ...	Yellow flesh.	..
Yellow-fleshed turnip ...	...	White-fleshed turnip (possibly bird rape).
White-fleshed swede ...	Yellow flesh.	...
Yellow-fleshed swede ...	...	White flesh, generally swede-like rape or hybrid.
White-skinned turnip ...	Tinges of red or green.	Red, green, purple.
Red-skinned turnip ...	White skin.	Green, purple.
Green-skinned turnip ...	White skin.	Red, purple.
Purple-skinned turnip ...	Red, green, or white skin.	...
Green-top swede ...	...	Purple-top, strong bronze-top.
Bronze-top swede ...	Green-top.	Purple-top.
Purple-top swede ...	Bronze-top. Green-top.	...

The colours given in the second column may have become incorporated in the mass selected strain, but they might be rogues due to admixed seed. The colours in the third column could not have been hidden in parent plants.

When a purple- or bronze-top swede is pulled up and left exposed to light, red colour develops on the lower parts, which while underground are completely without red colour. The green colour, however, does not appear when the under parts of a mature swede are exposed to light.

The occurrence of distinctly different colour types in crops of swede and turnip may now be attributed to several causes :—

(1) A bronze or green top swede found in a purple-top variety and in other respects bearing the general characteristics of the variety has probably arisen from the sorting out of non-purple-top factors which had been masked in the apparently true purple-top parent plant or plants. The actual introduction of the bronze character has probably taken place many generations before, or it may never have been eliminated if the variety was raised from a hybridisation. This is suggested because the bronze character is now separated from any other varietal characters with which it may have been associated. One well-known variety at the present day is frequently selected especially for the wide green band at ground level. This, as has been mentioned above, is a character very pronounced in the hybrid containing one purple-neck and one bronze-top factor, and consequently these hybrids when present are frequently chosen for seeding, and some of their progeny are bronze-tops; 5 per cent. of bronze-tops being found in one such strain.

(2) If the bronze or green top found in a purple-top variety should exhibit shaw and shape characters distinctly different from the variety type, the plant is probably a rogue of another variety, the seed of which has been mixed. In the varieties examined at this Station plants of this type are far less common than the kind described above.

(3) Purple-top swedes are occasionally found in bronze or green top crops. Some of these were shown to be true-breeding and evidently plants of another variety, while others were hybrids between a plant of the crop and some purple-top which must have been growing near during the seeding.

(4) White-fleshed plants in a yellow-fleshed swede crop are a matter of grave suspicion. The white-fleshed swede is so seldom grown that it need hardly be considered in this connection. The plants are more likely to be rape or swede × rape hybrids, the former if there is no bulb formation and the latter if there is a small fibrous bulb with fang-like roots. Nevertheless there was found at this Station a white-fleshed swede which in other respects resembled and bred true for characters of the soft-fleshed purple-top tankard variety from which it was taken.

(5) It is theoretically possible to have a similar con-

tamination of a turnip crop by a kind of "rape." The plant in question is known as "Winter turnip-like rape," "Rubsen," or "Bird seed rape." Its foliage is of turnip type and its flesh is white. The woody root is shaped like a fanged sugar-beet with a crown that may be coloured like the turnip skin. Moreover, when crossed with turnip the hybrids are fertile. Fortunately, however, it is not grown as a crop in this country, so that the chance of its occurrence among turnip is very remote.

(6) In turnip, skin colours which can be masked by others, i.e. recessives, as they are called, frequently occur in some varieties. Thus a red-skinned crop was found to contain over 1 per cent. of white skinned plants; while a purple-skinned strain showed red, green and yellow skinned rogues. White-skinned plants were not found in the green varieties examined, but they are theoretically capable of occurring. Exceptional plants of this nature are probably due to the hereditary constitution of the varieties, and are maintained by the seeding of plants hybrid for these colours but identical in appearance with the true-breeding plants of the strain.

(7) Like the purple-top rogue in the bronze-top swede crop, it is possible to have turnip plants with wrong skin colours in a turnip variety. These would be due either to admixture of seed or to hybridisation between a plant of the crop and other turnips.

The bulk of this paper has been devoted to the hereditary variations and environmental modifications affecting flesh and skin colours, in an attempt to elucidate how far these external differences may be employed as indications of the identity of the commercial variety. In themselves they are of little importance and have not been shown to affect the feeding value of the bulbs. It is known, of course, that the varieties of turnip with white flesh are softer and contain lower percentages of dry-matter than yellow turnips, but this may be a matter of the chance allocation of flesh colours to the original sources. The writer has attempted to find differences in dry-matter content between the red and white skinned turnips and between the purple and non-purple swedes in cases where second hybrid generations have contained large numbers of each type, but the results have been so far negative, i.e. both types in the crop gave approximately equal value for dry-matter content.

Summary.—The behaviour of skin and flesh colours in swedes and turnips is discussed. The manner of inheritance of these characters as found by various workers is briefly described, with some notes and amendments based on breeding experiments at the Scottish Plant Breeding Station. The importance of flower and flesh colour in guarding against contamination of swede crops by swede-like rape is emphasised. Reference is made to the discovery of homologous factors for purple-neck in swedes. The purple-neck or purple-top character of a white-

fleshed strain was found to be governed by a factor different from that which causes a similar condition in the common yellow-fleshed strains.

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THE BRITISH ADDER:

ITS NATURE AND HABITS.

NORMAN MORRISON, D.Sc., F.Z.S., F.P.C. (Lond.).

As the adder season is now beginning, I should like particularly in the interests of those who purpose visiting the Highlands this summer to give a short description of the appearance, nature, general habits, and last but not least the bite of this poisonous little viper, which lurks somewhere under the purple heather, ready to snap at the ankle of the intruder who encroaches on its preserves.

The adder (*Vipera berus*) is an interesting creature with a recalcitrant nature. This reptile will not feed in captivity, but will stolidly refuse to touch food, so that the cause of death of all adders in captivity is usually starvation. The reptile is also untameable. Its near relatives, the grass and smooth snakes, will feed when deprived of their freedom ; they can be tamed, and they are non-poisonous. The adder, which is found in England and Scotland, has a V-shaped imprint on its head. The apex of the V is towards the snout. Immediately behind this angle the adder is of a bright yellow colour, throwing into sharp relief the dark markings. Then proceeding along the back is a continuous zig-zag line with sharp pointed angles which is continued to the tip of the tail. On each side of the body is a row of drab brown, lozenge-shaped blotches. The markings often vary in sharpness and shade, but the design is always present in the adder family and never in the colour schemes of the ring and smooth snakes. It is further interesting to note that the tail differs in the sexes, that of the male being short and blunt, while the tail of the female is long and pointed (see Fig 1). This is an unfailing means of identifying the sex of these creatures.

Sloughing, that is casting off the old skin or epidermal covering, takes place two or three times a year. Whenever the coat

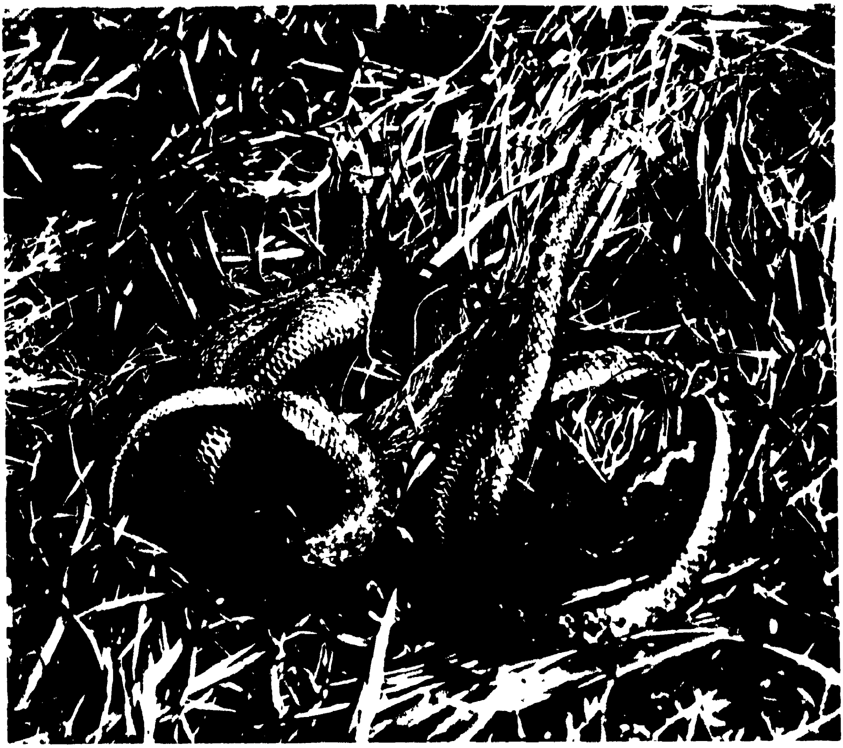

FIG. 1.

The adder at home—male and female. The distinction of the sexes is very apparent in this photo—the tail of the male is short and blunt, whereas the tail of the female is long and pointed. The markings of the male are also brighter and more defined.

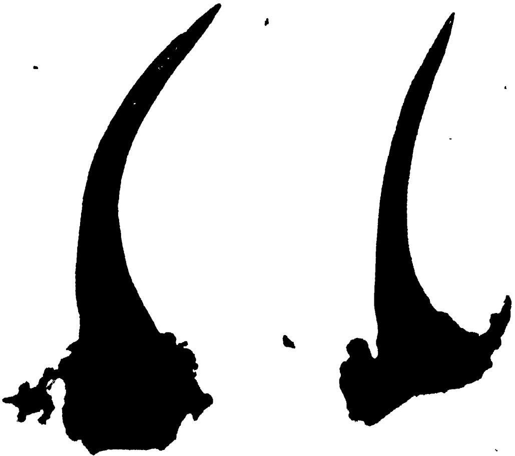

FIG. 2.

The fangs of the adder magnified 13½ times (lengthwise). The opening through which the venom comes is seen near the pointed end on the outer side of the fang to the left.

[*Photographs by N. Morrison.*

becomes ragged or frayed, Nature provides the reptile with a resplendent new garment, which shows its colours and graceful lines to perfection. Like other reptiles in frigid zones, it hibernates during the cold season.

The average length of the species is about 21 inches. The snake is viviparous, producing its young alive with an average of seven, and its natural food is mice, frogs, toads, lizards, and even rats. To refer to the adder sting is to repeat a common fallacy. The adder does not sting, and there is no danger to be feared from the forked shooting tongue. The danger lies in the reptile's bite.

The fangs of the adder are two slender, sharp-pointed teeth, barely a quarter of an inch long (canaled with an opening near the point), and curving inwards on each side of the upper jaw (see Fig. 2). They are firmly united to the maxillary bone, which is freely moveable. When not in use they lie in a sheath on each side of the palate.

The poison glands lie behind the eyes, the broadest part of the head. The poison secretion is conveyed by two ducts to the root of the fangs. When the adder is going to strike it opens its mouth to an angle of nearly 90°, erects its fangs and darts its forked tongue out and in with a low, hissing sound; then, swift as a lightning flash, the tongue is withdrawn and the sinister weapon plunged into the body of the victim. The action of the bite compresses the muscles of the poison glands, and drives a drop of the venom along the ducts, right up through the fangs, from the tip of which it is squirted into the wound.

The poison possesses a high ratio of blood-destroying (hæmolytic) element. The chemical compounds of the venom are very complex. It is a slightly viscid, clear fluid, sometimes of a yellowish tint, with a specific gravity varying from 1·030 to 1·081. It coagulates immediately on exposure to air, and it contains at least two distinct toxic proteids but no bacteria. The poison is harmless when taken into the stomach; its lethal action only appears when it enters the circulatory system. The most effective means of curing snake-bite is, therefore, to prevent the venom from invading the blood stream.

The following instructions if carried out immediately after the bite will restrain the operation of the poison and prove an excellent remedy for adder bite. First, without a moment's delay stop the circulation by tying a ligature tightly above the wound, that is nearer the heart. Second, cross cut the wound with a sharp knife, and encourage bleeding by sucking hard with the lips, if there is no broken skin about the mouth. Third, apply to the wound a few crystals of permanganate of potash if they are at hand, and if not, burn or cauterize the wound with a red hot wire, such as a knitting needle. Keep the patient quiet and give him or her a little stimulant and send post-haste for the doctor.

Until science discovers and manufactures an anti-venomous serum, this is the simplest and best cure known for adder bite.

The full bite of the adder, that is, when one receives a maximum discharge from both fangs, is always serious, and even a healthy person would have a bad time of it for weeks; but fortunately fatal cases are rare.

In this connection it is interesting to note that last summer a young man near Chatham was bitten on the right hand by an adder. In a short time the hand became badly swollen and the doctor in charge of the case recommended the use of an anti-venin serum. Telephone calls to London, however, elicited the information that this serum was not available in England, and as the case was growing serious, a telegram was sent to the Pasteur Institute, Paris, asking for the serum to be sent at once by aeroplane. This request was immediately complied with, and the serum arrived by the air mail. Injections were given and the patient through time began to mend. This incident is a sad commentary on British research work in herpetology.

The adder is a most nervous creature and will never assume the offensive except in self defence or to procure food, but will glide quickly under cover from the presence of an intruder. Doubtless my readers will be shocked to hear that I once dined off an adder, and the cooked reptile was by no means disagreeable to the palate.

THE following article is contributed by Professor Raymond T. Parkhurst, B.Sc. (Agric.), M.Sc., Director of the National Institute of Poultry Husbandry, Newport, Shropshire.

Modern Developments and Tendencies in Poultry Husbandry.

The poultry on the farm have been the salvation of many farmers during the past few years and the profits made have led the men to become interested in what used to be considered the women's job. This has resulted in poultry becoming a unit of the farm operations, and the unit will, if profitable, increase in size until it is actually an economic branch of diversified farming. The size of the unit may be a few hundreds or it may be thousands of layers, according to the size of the farm and the success of the enterprise. There is a promising future for an efficiently managed poultry unit. The coming competition will force out the type of poultry-keeper who has ignored modern developments and yet made money in the past. It is essential that more careful attention be given to the reduction of food, labour and overhead charges. Mammoth incubators, sex-linkage, battery brooders, intensive laying batteries, slatted floor houses, artificial lighting, pellet-feeding, and many other recent developments are rapidly changing the complexion of poultry keeping. It is becoming specialized and simplified. Centralised hatcheries are growing rapidly, and soon it will be possible to get better chicks at less cost than it will be possible to produce them on the farm. Poultry breeders should combine to form co-operative hatcheries. The future breeding of poultry will be conducted by specialists to an even greater extent than it is to-day, because greater attention will have to be paid to selection on the basis of genetic factors involved in the inheritance of egg production. When a farmer or a commercial poultry-keeper is able to purchase baby chicks that are well-bred, free from disease and vigorous, he is not going to bother with incubators. He cannot afford to do so. The same is true of brooding to a slightly less extent. Although there are fewer factors directly involved in successful brooding, it can be hard work and cause a lot of worry. It can be done better by specialists. There is an enormous future in the production of six and eight weeks old started pullets. When more is known concerning the use of the battery brooders and the management of the chicks after they leave them, they will be used to meet this demand. At present the battery brooder is under trial. It is reasonably successful for four weeks. By using " follow-on " units, chicks can be cooled off and hardened for several weeks previous to going to range. The future use of the batteries will be, to a great extent, a question of economics. Their use will probably be more general on large, rather than small, farms.

Soil contamination will be an even more serious problem than it is to-day. Intensive methods may have to be resorted to, especially after the first eight weeks. Under farm conditions, it should not be necessary. The cheapest and best way to rear pullets is on free range. Fresh land should be used each year and, if possible, the same ground should not be used more than one year in four. Inexpensive shelters are quite good enough for the growing stock, and those made principally of wire and roofing are rapidly being introduced.

For laying stock, the methods of housing tend towards the extremes. There is a tendency on the one hand towards the inexpensive slatted floor houses, and on the other hand towards the relatively expensive laying batteries. Both methods have possibilities and their development should be watched. A small investment in slatted floor houses by a poultry farmer is well worth while. The houses are excellent for growing stock, though they may not prove satisfactory for layers. At present the semi-intensive method of winter confinement and the use of summer range for layers seem preferable. The use of artificial illumination for layers is advocated, and the semi-intensive method of management is better adapted to lighting.

Because it simplifies the keeping of poultry by the farmer, the feeding of pellets or the mash mixture in a compressed form deserves consideration. By their use it may be possible to feed once a week only, and in this way save a considerable amount of labour. They are still in the experimental stage, but the results obtained should be studied, and it might even be advisable to try them on a small scale. Their use will usually save labour and reduce the waste of food. Each poultry-keeper must determine whether or not the increased price of the pellets over the mash (about 6*d*. per hundredweight) will leave a greater profit.

The " barn-door " fowl as we know it at present has no place in the modern programme. Even if a poultry-keeper does not go in for intensive or commercial methods of production, the least he can do is to have better stock, better houses, and better feeding methods in order to be able to produce more winter eggs of better market quality at a greater profit to himself.

Tile Drainage.

At a certain level ground is saturated with water. This level, know as the water-table, rises in times of heavy rainfall and falls in times of drought; it may reach the surface or it may lie very deep. Air is excluded from the ground below the table, hence that ground is useless for the roots of agricultural plants. The main object in draining is therefore to limit this level. By doing so, the root range of plants is extended and the water which the soil receives as rain is able to percolate through the ground. On certain ground there is natural drainage, but in the greater part of our arable land tile draining is required if the necessary benefits are to be obtained.

Economy and efficiency were never more essential than at present. Before proceeding with any scheme, therefore, due consideration must be given to the fundamental principles of drainage.

Depth of Drains.—The depth at which tiles should be laid depends on the texture of the soil and the character of the subsoil : the heavier the soil, the nearer must the drains lie to the surface, as the percolation of water through clay is much slower than through loams and sands. Thus, it has been determined that on heavy clays, such as are found on the Carse of Gowrie, a depth of from 2 feet to 2½ feet is quite enough; in deep loam and sand the depth may go to 3 feet and sometimes more; and in mossy soils it is advisable, where the moss is not more than 4 feet deep, to lay the tiles at the bottom of the moss. An impervious subsoil often causes difficulty. Where a subsoil of " till " is overlaid by a soil of about 2 feet it is preferable to lay the tile on the top of the " till "; where, however, the soil is shallower, the tile must go into the " till," and in such circumstances special precautions should be taken (c.f. Laying of Tiles). Where tiles cannot be laid at a greater depth than 18 inches there is danger that they may be disturbed and broken by cultivation, and such land is better laid down in permanent grass.

Interval between Drains.—The intervals between lateral drains depend on the depth of the drains, the texture of the soil and the rainfall. The best general guide on this point is local experience. On clays, intervals vary generally from 5 to 7 yards, on medium soils from 6 to 8 yards, and on open light soils from 8 to 12 yards. On rigged-up land, the intervals are definitely determined by the width of the riggs; and where there exists an old system which is not functioning sufficiently, it is difficult to escape from the necessity of laying new tiles exactly between the old ones. These considerations apply to regular systems; where wet spots alone are to be tiled the intervals vary considerably.

Gradients.—It is advisable to allow a fall of at least 1 in 300, although it is possible to drain with 1 in 600. There is diversity of opinion concerning the principle on which any system should be planned. Theoretically the best system would appear to be that in which the gradient continues to increase from the lateral to the outlet. Such a system would ensure the most rapid discharge of water and, as there would be no slowing down of water movement, there would be no sedimentation and choking of tiles. In practice it is not always possible to obtain this ideal, and the configuration of the land often determines the sites of the mains. Practical experience nevertheless has shown that laterals lying across the slope are generally more effective than those which run straight down.

In carse lands and where land is flat, levels must always be taken. On such land it is frequently necessary to allow lateral drains to discharge at both ends into leaders.

Outlets.—The outlets are of great importance; without a satisfactory outlet a scheme may be useless.

The practice of allowing each lateral to discharge into a ditch is a very bad one, as this increases considerably the possibilities of stoppages. Such laterals should discharge into a main drain with one outlet. Apart from decreasing considerably the number of outlets, it is frequently possible by laying such a main to secure a very good fall and thus render the whole system more effective.

At the outlet, glazed pipes are often used, but, if not, it is advantageous to lay the last few ordinary tiles in concrete. Where the outlet is liable to back-wash a valve is essential.

Size of Tile.—Generally speaking, laterals should not be less than 2½ inches, although old 2 inch tiles in good repair may be used for short laterals, especially when the gradients are very good. Where gradients are bad and particularly on clay, laterals should be at least 3 inches. The size of mains varies greatly with the area to be drained and the gradients; it is impossible to state a general formula for size. M'Connell in his " Agricultural Note-Book " gives a very useful and exhaustive table of the acreages which can be drained by various sizes of mains on varying gradients.

Lateral drains should not exceed 300 yards, and submains should be used freely to prevent laterals exceeding this length. The size of tiles in the laterals need not vary, but in long mains it is frequently economical to use a smaller tile at the upper reaches than at the outlet.

Laying of Tiles.—The actual laying of tiles and the joining of laterals and mains should be done by a skilled man; it is essential that the trench should be well bottomed and the tiles evenly laid. When the subsoil is clay or "till" it is preferable to cover the tiles with soil, and, when the land drained is permanent grass, the turf should be laid on the top of the soil. The top of the trench can be filled with subsoil. When the subsoil is "till," every attempt should be made to bring this layer of soil and turf lying above the tiles up to that point where soil and subsoil meet, otherwise the drain may not function well. Boards are necessary wherever the subsoil consists of running sand or moss.

Costs.—Although the actual execution of drainage work will be done usually under skilled supervision, the farmer may nevertheless assist, especially at those points where his assistance will reduce costs. He may, for instance, render digging less expensive by ploughing out the top surface and by completing the filling of the trenches with his own labour. The farmer's general supervision will be more effective if he is familiar with details of costs and measurements such as are given below :—

1. *Length of laterals per acre.*

Intervals between laterals.	Rods of 16½ feet per acre.	Chains per acre.	14½" pipes per acre (without breakages).
15 feet	176	44	2,420
18 ,, ...	146	36·5	2,007
21 ,, ...	125	31·4	1,727
24 ,, ...	110	27·5	1,512
30 ,, ...	88	22	1,210

General Formula $C = \frac{660}{F}$

C = Length of drains in chains per acre.
F = Distance apart of drains in feet.

N.B.—Main drains require to be computed separately; 10 per cent. of the length of laterals is a fair average for mains.

2. *Average cost of cutting, laying and filling tile drains.*

Tile.	Average land.	Clay.
	per chain.	per chain.
2½" and 3" laterals 2½ feet deep	4/–6/6	4/6–7/6
4" mains 3–4 feet deep	5/–7/6	6/–12/6

(*N.B.*—These figures have reference mainly to the S.E. area of Scotland.)

3. *Cartage quantity of tiles for average farm cart.*

	2"	2½"	3"	4"	6"	9"
Cart load ...	500	400	325	220	100	20-25

The Profitableness of Farming in Scotland.

THE first of what is intended to be an annual series of reports has been prepared covering the period 1928-29. Financial and other records have been obtained, through the medium of the Agricultural Economists at the three Scottish Colleges of Agriculture, from farms which are broadly representative of the agriculture of the North-East, East, South-East and South-West of Scotland. Each group is subdivided to distinguish the characteristic variations in the farming of these four areas respectively. A description is presented of the economic organisation of the farms in each group and sub-group, dealing with personnel engaged, capital invested and volume of turnover. The financial results are presented in a form which permits of broad comparison between the different areas and more detailed comparison between the groups of farms in each area. Considerable variations are shown to exist between the average profits in the several groups and between the profits of farms within each group. The causes of these variations are analysed in the light of differences in the character of farm production and farm costs. These differences are shown to have less bearing upon the comparative levels of profit than have changes in the course of prices. The effects of these price changes are expressed in terms of indices of production, costs and profits for each area, and the resulting changes in the relative economic welfare of farmers are indicated, regard being had to the modifications of farm practice which have been made in recent times. The adjustments in farm organisation suggested by current levels of prices and of costs are considered.

In order that a more truly representative view of the position of agriculture in Scotland may be given, it is necessary to select groups of farms from which records are obtained, having regard to the number and distribution of farms of various types and sizes in the country. To this end the Agricultural Statistics are being examined with a view to presenting for each district of Scotland in turn a statistical account of the farms in which the form of organisation for production is the basis of classification. The first of such studies for the counties of Berwick, Roxburgh and Selkirk forms an addendum to the report on farm profitableness in Scotland. These counties constitute an agricultural area within which sheep are the dominant feature of the farming, under systems which range from rearing on the hills to intensive feeding on the lower grounds. By the method of classification adopted the farms are ranged in a sequence in which the gradual changes from the hills to the lower lands are depicted, the number, size, cropping, stocking, and other features of the farms in each successive group being defined. This permits of samples being drawn, from the financial results of which the economic position of the whole range of farms may be determined. The small holdings in the area, farmed either for a living or as part-time occupancies, are separated from the main group of farms and the characteristics of each class are examined. The incidence of family farms within each separate group is also studied, and the number of farmers who are actual or potential sellers of each of the various agricultural products is ascertained. Thus the agricultural organisation of the area is statistically portrayed, while at the same time the basis is laid for the extension of advisory economic services.

The issue of the report has been retarded owing to the necessity for developing both the machinery for the collection of accounting information and methods for presenting the facts in suitable form. It is expected that a further report dealing with the profits of farming groups for 1929-30 will be ready in the autumn, and that thereafter the reports dealing with the situation to Martinmas each year will be portrayed in a report issued in the following spring.

The report, which is designated " Report on the financial results obtained in certain groups of Farms in Scotland in 1928-29, with a statistical account of the Farms in the Counties of Berwick, Roxburgh and Selkirk," can be obtained from H.M. Stationery Office, George Street, Edinburgh, price 2*s.* 6*d.*

Reviews.

An Agricultural Atlas of Scotland. H. J. Wood, B.Sc. G. Gill & Sons, 1931; pp. 64, with 19 plates and maps; price 3*s.* 6*d.*—Mr. Wood was formerly on the staff of the Geographical Department in the University of Glasgow, and is now an Assistant Lecturer in Geography in King's College, London, which has made a grant towards the publication of his book. He has been engaged for several years in the preparation of the Atlas, which for the first time provides a graphic interpretation of the Agricultural Statistics of Scotland. Its chief feature is a series of plates on the scale of 30 miles to the inch, in which the distribution of grass, of the principal crops and of the main classes of live stock is shown by dots, each representing from 25 to 100 acres or units. The distribution of the dots is based on the parish statistics of the Department of Agriculture, which are not published, but are made available for work of this kind. In order, however, to ensure as true a representation as possible, the dotting is limited to the actual area under crops and grass in each parish, the moorland, loch and forest area being excluded. The changes in the acreage of crops and grass and in the numbers of live stock since 1866 and in the produce of crops since 1884 are illustrated by large-scale graphs, and key maps show the parishes as numbered in the corresponding list. There is also a map showing the whole area of moorland, loch and forest, and a rainfall map.

After dealing briefly with the broad distribution of land in Scotland and with its soil and climate, the author discusses the distribution of crops, grass and stock as shown in the plates, and the characteristics of the various agricultural regions into which Scotland is divided.

Mr. Wood is to be congratulated on having made a definite contribution to the study of both Scottish agriculture and Scottish geography. His work should receive the attention of all who are concerned in these studies, and of the wider circle who are interested in the primary industry of agriculture.

The Atlas is well printed on excellent paper, and the maps and graphs are clearly reproduced. The price is low in consideration of the work involved. A few misprints will no doubt be corrected should a second edition be required.

Agricultural Progress. The Journal of the Agricultural Education Association.—The issue of this annual volume—the eighth of the series—maintains the high standard set by its precursors. Under the heading of " Modern Science and Agriculture " the main topic is Recent Progress in Poultry Husbandry, an appropriate choice in view of the occurrence of the World's Poultry Congress held at the Crystal Palace last summer. The influence of education and research upon the poultry industry in this country is discussed by Mr. Percy Francis and Mr. R. T. Parkhurst, and this study is continued in papers on Genetics, Diseases and Nutrition. Mr. Foulkes deals with poultry as a source of meat supply.

Interesting accounts are given of farming conditions in Shropshire and Warwickshire and of market gardening in Worcestershire, and Mr. Orwin contributes a short note on the system of farming adopted and successfully carried on by Mr. George Bayliss in Berkshire, whom he describes as the biggest arable farmer in England, occupying more than 12,000 acres of land, practically all under the plough; Mr. Bayliss keeps nearly 300 horses and employs nearly 300 men. His system eliminates stock and maintains fertility and freedom from weeds by the use of artificials and bare fallows, and by ploughing in stubbles and clover roots.

Mr. T. W. Fagan's article on the Influence of Management on the Nutritive Value of Herbage Plants is worthy of attention as a real contribution to knowledge of pasture management. Exceedingly useful and practical observations are likewise contained in the papers upon " Suitable Crosses for Fat Lamb Production " by Professor R. G. White; the " Feeding and Management of Breeding Pigs " by Mr. V. C. Fishwick; and " How to get a Tubercle-Free Dairy Herd " by Mr. J. Mackintosh.

Other articles on various subjects of agricultural interest, accounts of recent activities connected with agricultural science and practice, and reviews of notable books complete a readable and authoritative collection of papers, which merit careful study both by the practical farmer and the agricultural scientist.

The International Live Stock Atlas. Volume I, International Cattle Atlas. Section, Switzerland. 1930. The International Institute of Agriculture, Rome. Bestetti and Tumminelli, S.A., Editeurs. pp. 49, 4 figs, 11 tables+1 map. Size 17 ins. x 12¼ ins. 25 Lires.—The International Institute of Agriculture has undertaken the task of compiling an International Live Stock Atlas. The portions already completed are those treating Switzerland, the Netherlands and Germany, and the Swiss volume is under review.

The summary of cattle breeding in Switzerland, which occupies the main body of the volume, is given in French, English, German and Italian. It is very well written, and its brevity is commendable in view of the large amount of information condensed within it. There are diagrams demonstrating points of economic interest, and the Atlas contains two pages of photographs representing a male and female of each of the four Swiss breeds of cattle.

In Switzerland the greatest density of cattle is to be found on the Plateau, and it thins out rapidly towards the Jura and the Alps. On the average there are 409 head of cattle per 1,000 persons, mostly owned by farmers of the smallholder class.

The four Swiss breeds of cattle are the Simmental, the Brown Swiss, the Fribourg and the Eringer. The first, a triple purpose breed, is the most important, the second has been selected along dairy lines, the Fribourg is an exceptionally large animal, triple purpose in character but not so highly selected as the Simmental, and the Eringer is a breed of small black or red animals.

The map of the Atlas illustrates the disposition of the breeds in Switzerland, a distinct colour being given to each. Then there is a transparent overlay which shows the density of cattle in different parts of the country.

The high value of the International Live Stock Atlas will be realised more fully when it is completed and can be judged as a whole rather than in separate parts. It will be invaluable to those interested in the ecological or economic aspects of live stock husbandry.

THE following article is contributed by Dr. Norman Morrison :—

Remarkable Behaviour of Bees.

The bee is an insect which belongs to the order *Hymenoptera*, and like the rest of its class undergoes metamorphosis, dividing the life of the creature into four stages, viz :—the egg, larva, pupa and imago. It is interesting to note that man with all his ingenuity has used only two insects for domestic purposes, the honey bee and the silkworm. The intelligence of bees is proverbial, but it seems that we have not yet found out the whole history of the singular intelligence and resourceful nature or capacity for adaptation to environment of the bee family, which the following incident fully illustrates. Last summer a colony of bees (three hives) kept by a farmer in the neighbourhood of Campbeltown made their cells and cell covers of a mixture of tar and wax—the former, which they collected on the main road near at hand, predominating.

As might be expected the whole stock of honey in the three hives was impregnated with tar, which rendered it unfit for use, yet the bees were not in any way affected as the result of feeding on a mixture of tar and honey. In this connection it should be noted that coal tar contains a saccharine principle plus adhesive substance. The former element is the natural food of these insects, and the latter when mixed with a percentage of wax makes an admirable material for constructing the cells of the hive. Moreover, this substitute was a great saving of labour to the bee colony.

Under ordinary circumstances the workers in a hive gather a secretion known as "propolis," which is a resinous matter found in various trees and plants. The bees procure this resin by means of their mouths, convert it into a paste and carry it home in a receptacle in the hind leg. Thereafter it is mixed up with the wax for forming the cells, making the preparation adhesive and elastic. It also lines the interior of the cells. It would therefore be obvious that by using tar instead of propolis the colony saved themselves an immense amount of labour.

The behaviour of these creatures is without a parallel in the history of the species. It is truly a new phase of the intelligence and investigating powers of bees. I have already referred to man's use of the bee. Is this anomaly the result of these insects being subservient to the will of man? No one knows. In any case, if in the future bees in general follow the methods of the Kintyre colony, what will happen to our honey supply?

Conference of County Organisers.

DURING recent years the Department have arranged from time to time Conferences of Scottish County Organisers for the purpose of discussing specific subjects of agricultural interest. This year the Conference was held at Aberdeen on 27th, 28th and 29th May and the subject selected was Pigs and Pigkeeping. By courtesy of the University Authorities, the meetings took place in Marischal College on the forenoons of each day, and the afternoons were devoted to visits to places of agricultural interest in the vicinity of the city.

Principal Sir George Adam Smith, after welcoming the delegates, said that the University Authorities in Aberdeen were proud of their close connection with the North of Scotland College of Agriculture and paid a warm tribute to the admirable and efficient work of the county organisers, whose labours were conducive to great benefits to the agriculture of the country.

The chairman, Sir Robert Greig, thanked the Principal and the University Authorities for the privilege of holding the Conference in these buildings, and expressed his pleasure in meeting the County Organisers who were responsible for carrying out so much of the important work of agricultural development.

After speaking of the difficulties with which the modern organiser is faced in keeping pace with the tremendous output of reports on all aspects of modern scientific research in agriculture, the Chairman indicated that, although the time for such a change was not yet ripe, it seemed inevitable that the organiser of the future would not be able to act as a general adviser as at present, but must fit himself to become more or less a specialist in some particular branch of the subject. The work of a County Organiser was so varied and entailed so much travelling that exact study of a wide range of subjects was difficult, but as Bacon said—" One should study what one most affects, and there must be some nucleus of interest in the mind of everyone round which a greater interest can be built, and as knowledge grows, interest is stimulated."

There were many branches from which one could choose; but the principal need in Scotland at present was for specialists in Animal Husbandry. It was rather odd that they should in the past have paid so much attention to the problems affecting crops, soils and fertilisers when their major interest in these questions was their concern with live stock. It was appropriate, therefore, that pigs and pigkeeping should be the subject of the present Conference.

The afternoon excursions were made to Messrs. Reith's farm of Kennarty, where some excellent types of live stock were shown; to Craibstone Experimental Farm, where the party visited the drainage gauges under the guidance of Professor Hendrick; and to the Rowett Research Institute, where the various lines of experimental and research work were explained by members of the staff.

A copy of the programme of papers is appended :—

The Place of the Pig in Scottish Farming Economy. Mr. R. G. M'Clymont.
Pig Keeping in East Lothian. Mr. R. B. Kerr.
Utilisation of Home Produce. Mr. R. Findlay.
Pig Feeding in the South-West. 1. Mr. John Kirkwood; 2. Mr. Hugh Young.
Some Pig Production Costs. Mr. W. Middleton.
Practical Aspects of Feeding and Management. Mr. A. Crichton.
Importance of Minerals and Vitamins. Dr. Orr and Mr. Blissett.
Production and Marketing of Commercial Pigs. 1. Dr. A. Calder; 2. Mr. J. Kirkpatrick.
A Farmer's Search for the Bacon Pig. Mr. D. W. Innes.
Selection and Management of Breeding Pigs. 1. Mr. A. D. Buchanan Smith; 2. Mr. J. M'Kessack Leitch.
Housing and Equipment. Professor Linton.

Worm Infestation of Pigs. Dr. D. Robertson.
Swine Erysipelas; Foot-and-Mouth; Tuberculosis. Mr. John C. Grant.

The Department are indebted to the contributors of these papers, and particularly to those farmers engaged in pigkeeping who willingly assisted in making the Conference a success.

Virus Diseases of the Potato.

THE Department have issued a leaflet on "Virus Diseases of the Potato and their Control," which gives brief and readily understood descriptions, with illustrations, of leaf roll and severe mosaic, the diseases responsible for the degeneration of potato stocks. The manner in which degeneration takes place and the conditions favourable to its occurrence are detailed. The measures of control that are recommended are those that have proved successful in actual farming practice. The chief remedy is the removal of diseased plants before the potatoes are finally earthed up. Rogueing after this operation is not so effective and never gives satisfactory results.

The issue of the leaflet at this time is of particular importance in view of the public interest in the improvement of Scottish seed potatoes.

Copies of the leaflet may be obtained on application to the Department of Agriculture for Scotland, York Buildings, Queen Street, Edinburgh.

Colouring Matter in Wool.

THE Department are advised that within the last three or four years quantities of wool have been coloured with a substance that causes the wool to become a brilliant orange yellow on being scoured. Analysis of this colouring matter by the Wool Industries Research Association shows that it is a substance known as Metanil Yellow, which may be a component of some dips or may be an added substance for the purpose of giving bloom to the wool. The substance is a dye-stuff with a strong affinity for wool. The colour thus given to the wool cannot be removed in the course of ordinary commercial processing, and therefore definitely spoils the wool for manufacturing purposes. In these circumstances, farmers are strongly advised to avoid the use of dips or washes which may contain this substance.

Farm Wages in Scotland.

As usual the Department issued with their Monthly Agricultural Reports for 1st January and 1st July supplements giving the wages of various classes of workers at Martinmas 1930 and Whitsunday 1931. This article summarises those statements and gives a comparison with the wages current at Whitsunday 1930; similar articles appeared in the issues of the JOURNAL for July 1929 and July 1930.

The pecuniary values of the allowances given in addition to cash wages, as reckoned at each of the three terms mentioned above, are as follows :—

	Whitsunday, 1930.	Martinmas, 1930.	Whitsunday, 1931.
Meal, per cwt.	12*s*. 6*d*.	12*s*. 6*d*.	13*s*. 6*d*.
Milk, per gallon	1*s*.	1*s*.	1*s*.
Potatoes, per ton	£2	£2, 10*s*.	£5
House, per annum	£6	£6	£6
Coal, per ton	£1, 15*s*.	£1, 15*s*.	£1, 15*s*.
Board and lodging for single men, per week	14*s*.	14*s*.	14*s*.
Bothy accommodation, with attendance, per annum	£9	£9	£9
Bothy accommodation, without attendance, per annum	£6	£6	£6
Keep of cows and followers, per cow, per annum	£12	£12	£10

The increase during the year in the estimated value of a hundredweight of oatmeal would mean, for men who receive 65 stone per annum, about 2*d*. per week, while that in the value of potatoes would mean, for men getting a ton a year, about 1*s*. 2*d*. per week. The fall in the estimated value of a cow's grazing would mean a reduction of about 9*d*. in the weekly remuneration in respect of each cow kept. For the other items the values show no change throughout the period.

The arithmetical averages of the Department's figures for the wages of married men are as follows :—

Average Weekly Earnings of Married Men.

	SUMMER, 1930.						WINTER, 1930–31.						SUMMER, 1931.					
	Cash.		Allowances.		Total.		Cash.		Allowances.		Total.		Cash.		Allowances.		Total.	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Ploughmen ...	29	4	7	3	36	8	29	0	7	5	36	5	28	3	8	3	36	6
Cattlemen ...	31	1	7	6	38	7	30	7	7	7	38	2	29	8	8	7	38	3
Shepherds ...	28	10	9	6	38	4	29	0	9	7	38	7	28	3	10	3	38	6

The total in each case shows little change as compared with that for last year, the cash wages being less by from 7*d*. to 1*s*. 1*d*. per week, while the values of the allowances are greater by from 9*d*. to 1*s*. 1*d*.

Married Ploughmen.—The following table gives in round figures the weekly earnings of married ploughmen in summer 1930 and in summer 1931 in respect of 38 out of the total number of 50 counties and parts of counties included in the Department's wages statement:—

COUNTY OR DISTRICT.	SUMMER, 1930.			SUMMER, 1931.		
	Cash.	Allowances.	Total.	Cash.	Allowances.	Total.
	s.	*s.*	*s.*	*s.*	*s.*	*s.*
Wigtown	24	14	38	24	15	39
Kirkcudbright	32	3½	35½	31	4½	35½
Dumfries	34	3	37	34	3½	37½
Selkirk	34	4	38	32	6	38
Roxburgh	34	4	38	32	6	38
Berwick	34	4	38	32	6	38
Peebles	34	3	37	33	4	37
East Lothian	34	3	37	33	4	37
Midlothian	34	3	37	33	4	37
West Lothian	34	3	37	33	4	37
Stirling	39½	6	45½	38	6½	44½
Dumbarton	39½	3	42½	37	3	40
Lanark (N.W.) Lower Clyde Valley	36	3½	39½	36	4	40
Renfrew	35	3	38	34	4	38
Ayr (N.)	35	8	43	34	9½	43½
Ayr (S.)	35½	3½	39	33½	4	37½
Lanark (S.E.)	36	3½	39½	34	4	38
Clackmannan	38	½	38½	36	3½	39½
Fife (S.W.)	38	½	38½	36	3½	39½
Fife (N.E.)	28	9½	37½	25	12	37
Kinross	28½	9	37½	28	11	39
Perth (S.E.)	29	10	39	27	13	40
Perth (Central)	28½	9	37½	27½	10	37½
Angus (S.W.)	28½	8½	37	27	10	37
Angus (N.E.)	26	9½	35½	24½	11½	36
Kincardine	27	9½	36½	24	11	35
Aberdeen (E.)	24½	9½	34	22½	10½	33
Aberdeen (N.E.)	23½	10½	34	22½	11	33½
Aberdeen (Central)	23	9½	32½	20	10½	30½
Aberdeen (S.W.)	24½	9½	34	22½	9	31½
Aberdeen (N.W.)	23½	10½	34	21	10	31
Banff (N.E.)	25	6½	31½	21½	9½	31
Moray	25½	9½	35	24	10½	34½
Nairn	22½	10½	33	23	12	35
Inverness (E.)	22½	10½	33	23	12	35
Ross and Cromarty (E.)	24	10½	34½	22	12½	34½
Sutherland	18½	13½	32	18½	13½	32
Caithness	16½	14	30½	16½	15	31½
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
Average	29 9	7 0	36 9	28 3	8 3	36 6

The arithmetical average of the cash wages for these 38 areas is lower than last year by 1*s.* 6*d.*, while the value placed on the allowances is higher by 1*s.* 3*d.*

Most of the districts show a slight reduction in the cash wage, but increases of 6*d.* are recorded in Nairn and East Inverness.

The range of the total wages, including cash and allowances, in the various divisions of the country is as follows:—in the southern counties from 35*s.* 5*d.* to 43*s.* 5*d.*; in the south-eastern counties from 37*s.* to 38*s.* 2*d.*; in the Lower Clyde Valley from

37*s*. 9*d*. to 40*s*. 2*d*.; in the remainder of the central area from 33*s*. 8*d*. to 47*s*.; and in the north-eastern and northern counties from 30*s*. 6*d*. to 38*s*. 7*d*.

Single Ploughmen.—The average wage of single ploughmen in the south-eastern counties is 33*s*. 10*d*., or 7*d*. less than last year. In the south-western districts wages vary from 26*s*. 11*d*. in South Ayr to 32*s*. in Kirkcudbright, where there is a reduction of 1*s*. per week. In the Lower Clyde Valley and North Ayr the cash wage averages 17*s*. 3*d*. as compared with 18*s*. 2*d*. a year ago, with board and lodging valued at 14*s*. The average cash wage in the east-central division is 24*s*. 8*d*., or 1*s*. 11*d*. less than last year, while the allowances, valued at 6*s*. 3*d*., show a decrease of 2*d*. In the northern and north-eastern counties the average cash wage is 20*s*. 4*d*. and the value of the perquisites is 11*s*. 11*d*. In Scotland as a whole a single ploughman's wage is 31*s*. 7*d*. (cash 21*s*. 6*d*. and allowances 10*s*. 1*d*.).

Women Workers.—Female dairy workers generally receive board and lodging, which have been valued at 14*s*. per week, and cash wages ranging from 9*s*. 3*d*. in Orkney to 18*s*. 6*d*. in South Ayr and Central Argyll. In the Lothians and Peebles a cash wage of from 23*s*. to 24*s*. is paid, with no allowances. Other women's rates, including board and lodging or their equivalent, vary between 21*s*. 8*d*. in Orkney and 29*s*. in South-East Lanark. Where the whole is paid in cash the wages run from 18*s*. to 24*s*. per week. Women paid by the day generally receive from 3*s*. to 4*s*.; in Wigtown, however, the rates are from 2*s*. to 3*s*. 6*d*., while in South-East Perth from 2*s*. 6*d*. to 3*s*. 6*d*. is paid and in Stirling from 3*s*. to 5*s*.

Boys.—Where board and lodging are provided the estimated total wage ranges from 21*s*. 4*d*. to 26*s*. 4*d*., according to age and experience. In a few districts where the whole is paid in cash the rates are from 15*s*. to 24*s*.

Girls.—In the Lothians and Peebles girls generally receive 14*s*. per week, with no allowances. In those districts where board and lodging are provided the estimated total earnings are considerably higher in some cases, the rates varying from 20*s*. 11*d*. in Orkney and South-West Perth to 26*s*. 8*d*. in Kintyre.

Casual Workers.—Men are paid from 4*s*. to 6*s*. and in some cases up to 8*s*. per day; the weekly rate varies from 30*s*. to 36*s*. and in some districts up to 40*s*. Women are usually paid 3*s*. to 4*s*. per day, or 4*d*. to 9*d*. per hour.

Agricultural Conditions.

WINTRY conditions prevailed generally during the first half of March, and outdoor work was impossible in many areas on account of snowstorms and frost. In Central Perth the death-rate among early lambs was unusually heavy during this period. Towards the end of the month, however, the weather improved considerably, enabling arrears of farm work to be overtaken in most districts. Cold, dry weather prevailed during the greater part of April, and good progress was made with the seeding of cereals, while a beginning was made with the sowing of turnips. Towards the end of the month rain interrupted farming operations in many areas. During the first three weeks of May the weather was dry in practically all parts of the country, with low day temperatures and some ground frosts at night. The growth of crops was retarded to a considerable extent and live stock generally made slow progress, but the conditions were favourable for turnip-sowing and other seasonal operations. Rain fell in most parts of the country during the last few days of May.

At the beginning of June wheat was generally reported to be vigorous and healthy, although in some areas the plants were still rather thin on the ground. According to the estimates furnished by the Department's Crop Reporters it would appear that the area under wheat will show a further reduction this year.

Barley brairded very well; at the end of May the plants had a fresh, promising appearance, and no reports of damage to the crop by disease or insect pests had been received. Estimates of the area under the crop indicate that the acreage sown this year will show an even greater diminution than in the case of wheat.

The oat crop brairded rather slowly, but the rain and higher temperatures prevalent at the end of May improved the appearance of the plants. In most districts the area under oats is estimated to be practically the same as that of last year.

At the beginning of June beans were only just beginning to show above the ground in Berwick and Kincardine. Elsewhere the crop was healthy and vigorous; in Stirling the plants had an exceptionally strong appearance. Ryegrass and clover seeds have made good progress, and the reports at the end of May indicated that the hay crop this year would probably be well above the normal in bulk.

The planting of potatoes was practically completed before the end of May, under satisfactory conditions. From the estimates of acreage furnished by the Department's Reporters it would appear that the total area under this crop will prove to be slightly greater than in 1930. The sowing of root crops was fairly well advanced at the beginning of June. The reports received regarding sugar beet indicate some decrease in acreage as compared with last year.

As a consequence of the late spring, comparatively little damage was caused to fruit trees by frost, and the prospects are good; in North-West Lanark, however, the strawberry plants were reported to be patchy.

Pastures were rather bare during the spring months and at the end of May cattle were still lacking in condition in many cases. Serious losses have been reported from Berwick, Roxburgh and Selkirk through suckling cows being affected by convulsions associated with lactation, most cases having proved fatal. Sheep on arable farms have thriven satisfactorily, but in many areas hill sheep were reported at the end of May to be thinner than usual. The fall of lambs was less satisfactory than usual, and in a number of areas the yield was reported to be below the average. With the improvement in the weather conditions towards the end of May lambs made good progress generally.

At the beginning of June the supply of regular labour was adequate, but in North Argyll, Dumbarton, Renfrew and North Ayr dairy workers were said to be short of requirements.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Club Root in Cruciferous Crops. *J. G. Gibbs, Mycological Laboratory, Plant Research Station, Palmerston North, New Zealand. New Zealand Journal of Agriculture, Volume 42, No. 1.*—Notes are given of a survey of the relation of cruciferous crops to disease in the Wellington, Hawke's Bay and Taranaki provinces of New Zealand during the season 1927-28.

One of the most significant experiences of the survey was the statement made by farmers that were it not for club-root ("finger-and-toe") and dry-rot they would grow swede turnips, &c. in place of mangels and the other substitutes that are grown to-day. In the Hutt Valley district all were agreed on the low amount of infection experienced in the winter crops, and opinions were very consistent regarding the period of persistence in the soil. The general tendency in New Zealand has been to deprecate the use of lime as a remedy for club-root, but two of the growers interviewed in the Hutt district were convinced of its value.

The results of experiments at the Plant Research Station showed that infection was governed by spore load, though there was no simple relation between the number of spores and degree of infection. A fairly large concentration of spores was necessary before any infection occurred. In view of this it appeared that the chance of seed-borne spores causing general club-root throughout a field, though possible in odd cases, was practically remote, as no workers had yet succeeded in isolating spores of the club-root organism.

Tests to locate biological strains of club-root pathogenic to only one host or to a series of hosts gave inconclusive results. Recent work had indicated that as seed is sown later into the autumn less club-root appears in the resultant crop.

As a result of observations in 1911, the Superlative variety of swede was considered to be highly resistant to club-root, but this property was not so apparent in the Superlative type of swede at present on the New Zealand market. The most resistant swede available in New Zealand is the Danish variety Herning, which was selected from Studsgaard Bangholm swede. Crimson King swede has been twice recorded in New Zealand as the most susceptible swede to the disease.

The recommendations for control are based on preliminary experimental evidence and are offered tentatively. No method of complete control suitable for practical application on a farm has yet been evolved, but the knowledge of means of dissemination, the eradication of weed hosts which enable the disease to persist while a cruciferous crop is not in the ground, and the use of club-root-resistant lines of swedes and turnips should effect a marked reduction in the severity of the disease. If slag and potash were used as fertilisers a further reduction of club-root should be effected, but manures containing superphosphate, sulphate of ammonia and basic super were likely to increase the incidence of the disease.

The Yield of Sharply Contrasting Pasture Types and their Response to Manures. *By R. G. Stapledon, M.A., and M. T. Thomas, B.Sc., Welsh Plant Breeding Station, (Bulletin) Series H, No.* 11, *Seasons* 1921-29.—Amongst the conclusions drawn from the trials by the authors are the following :—

Good temporary leys sown with indigenous species show a high yielding ability when compared with really good permanent pastures on relatively similar soil types.

The all-the-year round yields of upland pastures are poor compared with those of lowland pastures.

The application of nitrogenous manure to a field which is heavily grazed reduces the proportion of wild white clover in the herbage, and this reacts adversely on the mid-season yield of swards to which this clover is a heavy contributor.

This fact points to the necessity of regulating very carefully the grazing on areas treated with added nitrogen so as to maintain a proper balance between grasses and clovers.

The upland pastures have responded relatively better than the lowland to phosphates, potash and nitrogen.

These trials have shown how very amenable upland swards are to treatment, and tend rather to suggest that the improvement of hill grazings may well be a comparatively easy and in many cases an entirely economic proposition.

The Source and Nature of Variability in a Strain of Marquis. *By J. B. Harrington, Scientific Agriculture, Volume* 11, *No.* 1.—In Western Canada, Marquis occupies far more land than all other wheat varieties together, but during its twenty years of economic existence it has become more or less contaminated by admixture of other varieties and by natural crossing.

The purposes of the investigations were :—

(1) To ascertain more definitely the response of natural crossing for Marquis variability; and

(2) To determine the nature of Marquis off-types especially with respect to the inheritance of critical spike and glume characters.

The result of various progeny tests and of an artificial cross between two types indicates that natural crossing was responsible for most, if not all, the plants of a certain type. There appeared to occur in Marquis an amount of natural crossing much larger and more important than is generally recognised. It is believed that differences in type within a variety lead to the production of various intermediates some of which breed true while others do not breed true. These intermediates produce an array of forms varying from one parent type to the other and constitute no small difficulty in the improvement of the variety by selection. Environmental differences did not mask inherited differences where these differences were distinct. There were small but distinct general differences between material grown in 1925-1927 and 1928 which were obviously the result of seasonal conditions. Environmental differences may easily obscure small general similarities and differences.

SOILS.

Conservation and Availability of the Nitrogen in Farm Manure. *A. Floyd Heck. Soil Science, XXXI,* 335 (1931).—Although a considerable volume of work has been done in this country and abroad upon the making and storing of farmyard manure, and the published data made more or less available to those interested in the subject, comparatively few of those engaged in the practice of agriculture realise the extent to which the valuable nitrogenous constituents of dung are lost and the causes of that loss. In too many cases no attempt is made to prevent the loss of nitrogen compounds.

This contribution to the subject comes from the Department of Soils in the University of Wisconsin, U.S.A., and gives an account of laboratory and greenhouse studies of the changes, losses and availability of the nitrogen in farm manure.

The author states that during the year the average dairy cow produces about 13 tons of manure containing 130 lb. of nitrogen, of which about 70 lb. are in the liquid portion. The nitrogen content of the manure varies with several factors—kind of animal, kind of feed, season of the year, amount and kind of bedding, and methods of handling the manure. The excrement from cattle consists of about 70 per cent. solid and 30 per cent. liquid by weight. The nitrogen content of the dung varies from 0·2 to 0·45 per cent., and of the urine from 0·8 or less to over 1·5 per cent. If the dung and urine is mixed with enough straw as bedding to absorb the liquid, a complete manure is obtained which contains from 0·5 to 0·55 per cent. nitrogen, half of which is from the liquid manure. If this manure is allowed to stand a few days the nitrogen from the liquid manure changes to ammonia, and the result is a manure containing 10 to 12 lb. of nitrogen per ton, of which 5 to 6 lb. are in the form of ammonia. Analyses of farmyard manure from a number of farms showed that there was less ammonia nitrogen in the samples than should be found if the total excrement was composted with the bedding. The shortage indicated that either there had been a loss of ammonia from the heap or part of the liquid manure nitrogen was not incorporated with it.

On many farms the liquid manure, or draining from the manure heap, is stored in underground tanks or chambers, and unless precautions are taken considerable loss of ammoniacal nitrogen occurs. When the liquid is stored alone, the nitrogen changes to ammonium carbonate and is lost by volatilisation. This loss may be reduced to almost nothing by covering the surface with a thin layer of mineral oil. Although the tank may be open, there is practically no loss of nitrogen through the oil layer.

The storage of farmyard manure should accomplish three things, the inclusion of all the liquid excrement, prevention of any washing away, and the maintenance of anærobic conditions. The first is secured by the use of gutters for the prevention of loss and the use of sufficient bedding to aid absorption. Washing away is prevented in uncovered heaps by the use of some watertight container so that no liquid is lost. The author stated that it is unnecessary to have this container covered—in fact, unless the rainfall is very high, it is better for the manure to receive the normal rainfall so long as there is no washing away of soluble constituents. This rainfall provides the necessary moisture to produce and maintain anærobic conditions, and these conditions are better produced by packing the normally moist manure than by waterlogging. European farmers are careful of this point and often use animals for packing. If this storage is done properly, the end product will contain practically all the nitrogen in the original dung and urine.

The handling and spreading of anærobically stored dung must be done properly if minimum losses are to be obtained. Three-eighths to one-half of the nitrogen is easily lost by exposure to drying conditions. Warm, dry, sunny days with wind produce conditions which cause greatest losses. If the spreading is done during cool, rainy weather, and the manure incorporated with the soil immediately, the losses may be reduced to a minimum. The handling is made much easier if cut straw is used for litter. The author states that the practice of applying *fresh* manure to snow-covered fields in winter gave low handling losses, but if *fresh* manure is spread and allowed to lie on the land during warm sunny weather, ammonification takes place within two or three days and the losses may be heavy.

The available nitrogen in farm manure is largely confined to the ammonia or water-soluble portion. Very little of the dung nitrogen is readily utilised by crops. Only in the case of fermented dung does any appreciable amount of dung nitrogen become available. When straw is used for bedding to absorb the liquid, it not only acts as an absorbent, but also aids in decreasing the losses on drying after the manure is spread. Although the straw is an advantage in this respect it is a decided disadvantage in the amount of manure nitrogen recovered in the crop. The straw furnishes energy for the growth of soil micro-organisms with a resultant depression in the nitrate and available nitrogen. As a result the greater amount of straw used as bedding, the greater the depression in the availability of the manure nitrogen. This depression is especially marked in the first crop following the manure application.

Investigations into the Intensive System of Grassland Management: II. The Seasonal Variation in the Mineral Content of Pasture with Particular Reference to Drought. *W. S. Ferguson. Journ. Agric. Sc.*, *XXI*, 233 (1931).—This further communication from the Agricultural Research Staff of Imperial Chemical Industries deals with pasture sampled daily from

May to October, and weekly afterwards, during the exceptionally dry season of 1929. During the greater part of the investigation there was severe drought and little growth took place.

Little information is available on the mineral content of pastures during drought, but some workers have found a reduced assimilation of lime and phosphate by hay during continued dry weather, but an increased intake after resumption of moist conditions.

The data presented in this paper indicate that the lime content decreased slightly during the drought and a more marked fall occurred in the months of heavy rain from October to December, while phosphate fell until the onset of rain, when the percentage of this constituent rose rapidly. Potash rose during June and July, but a decrease was noted during the droughty period in August and September. The content of this constituent was irregular. The sodium content remained steady during the drought and showed an increase during the rainy period. Chlorine showed a definite increase in the dry period and a decrease with increased rainfall. Nitrogen was dependent to a marked degree on the rain throughout the year—the content during the drought being low, and with the onset of rain much higher.

Investigations into the Intensive System of Grassland Management: II. The Mineral Content of Intensively Treated Pasture and a Relationship between the Nitrogen and Phosphorus Contents. *A. W. Greenhill and H. J. Page. Journ. Agric. Sc., XXI*, 220 (1931).—This contribution from the Agricultural Staff of Imperial Chemical Industries at the Research Station, Jealott's Hill, Berks., forms the second part of a series of reports on investigations carried out at three centres. The first part (*Journn. Agric. Sc., XX*, 573, 1930) contained data as to the organic constituents of the pasture, while this second part presents data as to the mineral content, covering three to five weeks' growth of herbage at the three centres in two seasons.

Throughout the period under investigation the percentage of lime present in the herbage fluctuated considerably but showed no definite seasonal trend. The prosphoric acid content showed definite seasonal variation, decreasing during drought or the early summer flush period and rising again afterwards. The average phosphate content was markedly lower in the dry season of 1929 than in the wet season of 1927. The total ash content showed fairly regular increase during the season in 1927, but somewhat irregular fluctuations in the dry season of 1929. Comparing the non-intensive plots with the intensive plots at one of the centres in 1927 there was no appreciable difference in respect of the average lime content, but the pasture on the intensively treated plot contained a rather higher proportion of phosphate and total ash than that of the non-intensive.

DAIRYING.

The Milk Yield of Pedigree Red Danish Dairy Cattle, being a Study of the Records as published in the Danish Herd Books (Advanced Registry), *Volumes* 1-5, 1920-1925. *By Lars Frederiksen and P. S. Ostergaard. Royal Veterinary and Agricultural College, Copenhagen*, 1931.—This paper, or rather booklet, is a statistical study of 7,000 lactation periods from about 1,200 pedigreed Red Danish cows during the years 1920 to 1925. In 1920 the qualifications for entry demanded at least three years of officially recorded milk yield with an average of 882 gallons at 3·6 per cent. butter fat. Since 1928 the standard has been raised to 990 gallons at 4 per cent. fat, and in addition the cows must pass an examination in respect of conformation. On this basis 500 cows are admitted every year to the Advanced Registry. The total population of dairy cows in Denmark is 1,600,000. Of these 800,000 are Red Danish, and it is from these that the "upper 500" are selected. Consequently the application of the results from a scientific aspect is somewhat limited. Nevertheless, certain factors can be hopefully studied owing to the fact that nutrition and management as a whole are remarkably even in the herds from which the *élite* have been drawn.

With commendable candour the investigators make it perfectly clear that the yearly records as officially published (which are based on the yield in a fiscal year, from October 1st to September 31st) make a rather poor expression for the comparison of the yields of heifers and young cows. Only those cows calving in the autumn up till the end of December can be included in the current year. Calvings after January 1st have to wait twenty-one months before a record concerning them is published, and then the record will include a considerable part of the second lactation and will also include the dry period. In view of the fact that the yield of a cow for her second lactation is considerably higher than in her first, it is obvious that anomalous results may be expected from this system. In addition there is a consequent delay in obtaining the figures which are essential for an examination of the breeding qualities of a bull which can be based on the progeny test, that is to say the yields of his daughters. In Denmark considerable stress is laid upon the progeny test. The writers suggest that this method (which is the method adopted by the Ministry of Agriculture in England) should be changed, and that besides the yearly records the average daily yield and maximum daily yield after the first and second calving should also be stated, so that it will be possible to compare yields from heifers and young cows which have calved at different times in the year.

This investigation shows that there is a constant relation between the maximum daily yield, which is usually obtained 30 to 40 days after calving, and the average daily yield during a lactation period. It is expressed as follows :—

$$\frac{\text{Highest daily yield}}{\text{Average daily yield}}=\frac{100}{70},$$

the average daily yield being 70 per cent. of the maximum. Thus, if a cow during the first two months gives four gallons as the highest yield in one day she is likely to yield $\frac{40\times70}{100}=28$ lb. as the average daily yield during the lactation. For heifers calving very young, as for instance two years or younger, the fraction is 73 or 74, but otherwise 70 per cent. is near enough. Length of dry period does not affect this fraction, neither does the length of the lactation period unless that period is twice as long as normal, in which case the percentage is reduced to 64.

Thus it is possible to calculate two months after heifers have come into milk how much they will yield in the first lactation, and also by correcting for age what they will give in the succeeding lactations. The authors add, however, that for calculating lactations it is better to use as a basis the average daily yield.

The average time between calvings was found to be 13 months or approximately 400 days. Of this 360 days was the normal length of the lactation, followed by an average of a 40-day dry period. The length of time between calving and service, known as the service period, was found to be 120 days. In the 114 days following service no lowering of the yield was observed as a result of pregnancy. This was calculated by comparing the decrease of yield in pregnant and non-pregnant cows. From 114 to 154 days after conception the milk curve dropped slightly, and after 154 days there was a rapid decrease. Initial yield increases with subsequent calvings, but persistency of yield decreases with age. The increase in production with age is therefore caused by a higher initial yield.

As regards the effect of the month of calving on total yield the writers found no difference save in the years 1917 and 1918, when there was a shortage of protein food stuffs. At that time the February to March calvers showed much higher yields than did the July, June and May calvers. Most of the cows freshened during October (14 per cent.). Altogether, during the four months September to December inclusive, 47 per cent. of all the calvings take place. The fewest calvings occur in May, June and July.

The effect of the age of the heifer at her first calving upon her subsequent yield was studied. On the average heifers first calve down at 27 months of age; two-thirds of the heifers calve between 23 and 28 months inclusive. The older the heifer at time of calving, the bigger her yield : at three years old she will give 20 per cent. more than a heifer calving at two years old, and a heifer calving for the first time at 30 months will give 11 per cent. more than one calving at 24 months. Between 23 and 28 months there was no even increase, though a marked tendency showed that other factors played a certain part particularly as regards the inherited milking capacity. Care and nutrition of the young stock has been remarkably uniform. This is stressed several times.

As is generally known, there is an increase of milk yield with an increase of age, and that this increase becomes smaller until the sixth lactation, when the yield is inclined to go downwards. Similar results were obtained in this investigation. The highest yearly yield was found from cows aged seven to eight years, and the writers add that it is not to be doubted but that the age of maximum lactation yield is much the same irrespective of breed and irrespective of whether the cow be a low or a high yielder.

There is an interesting note that the majority of the cows have to go to the butcher after the third or fourth, or at any rate the fifth calving. Of more practical significance is it to know the increase in yield from the first to the second lactation. This will be seen in Table I.

TABLE I.

Lactation.	Number of periods.	Lb. milk.			Relation figures.		
		Highest daily.	Average daily.	Total yield.	Highest daily.	Average daily.	Total yield.
1.	1,179	31·1	23·0	8,368	71·3	175·5	*76·3*
2.	1,196	38·2	26·9	9,281	87·5	89·4	*87·8*
3.	1,188	43·5	30·2	10,540	98·7	99·0	*96·5*
4.	1,064	46·0	31·8	11,230	105·6	104·9	*102·7*
5.	870	47·2	32·6	11,523	108·9	107·9	*106·6*
6.	619	*47·7*	*32·9*	11,647	*109·5*	*108·6*	*108·5*
7.	422	47·5	32·5	*11,898*	108·2	107·5	*108·6*
8.	257	46·3	32·0	11,578	105·9	105·2	*107·2*
9.	131	45·9	31·2	11,118	103·2	102·4	*104·6*
10.	63	43·3	30·1	10,913	101·2	99·5	*101·1*
	6,989	43·7	30·3	10,810	100	100	100

The yield is expressed as a percentage of the average of the first to tenth lactations, and the figures are in close agreement with those found by Kay and M'Candlish with Ayrshire cows (*Scot, Jour. Agric.*, 1929, July). The difference at first lactation can be explained by the fact that as a rule the heifers in the West of Scotland are 30 months of age when they first calve, whereas they are but 27 months in Denmark.

Concerning fat percentage there is not much written, but it was found that there was a slight but insignificant increase from the first to the third calvings. The writers are of opinion that fat percentage is not so much affected by environment (particularly nutrition) as is the milk yield, and, *provided the milk yield is held constant*, the butter fat percentage is a factor which should be considered and studied in any investigation concerning the inheritance of milk yield.

A dry period of more than one month results in a higher yield. It must be remembered in using the average daily yield as a measure of milking capacity that if the length of the lactation is extended to twice the normal, i.e. around 500 days, then the average daily yield should not be used. The total yield in such cases will rise far more than the decrease of the average daily yield would indicate. However, the average daily yield is a good measurement for cows with a lactation lasting anywhere from 280 to 380 days, and particularly so for the comparison of the yields of heifers. The writers state that this method should be preferred for the yearly record as previously discussed.

In an appendix figures are given for the average weight and measurement of bulls and cows exhibited at the fairs in 1930. These are as follows :—

Bulls aged :	*1*	*2*	*3*	*4* years.
	880	1,430	1,760	1,980 weight in lb.
	67	79	87	91 inches at girth.

The average weight of cows was found to be 1,320 lb., corresponding to 76 inches of girth, the relation of weight to breast circumference being as follows :—

1,100	1,212	1,325	1,430 weight in lb.
180	186	192	198 cm. breast circmf.
71	73	75	78 ins. at girth.

This is a valuable and interesting paper. The attempt of the writers to overcome the difficulties inherent upon a calculation of the lactation depending upon an arbitrary and fixed year is ingenious and has much to commend it. Their difficulties should serve as a warning to other countries that the milking capacity of a cow should be measured not upon an arbitrary twelve months but upon a natural lactation period.

A New View of the Effect of Temperature on Milk Production in Dairy Cows. *By K. W. D. Campbell.* 1931. *Jour. Agrl. Science, Vol.* 21, *Part* 1, *pp.* 167-177.—Little is known concerning the effect of temperature upon yield or quality of milk. We are much indebted to the present author for his venture into this field. The investigation appears to have been conducted with the greatest care and attention was paid to the possibility of other factors, such as change in the quantity and type of food, change from one pasture to another,

&c., affecting the results. It would appear to be evident that the one environmental factor during the summer of 1928 that was least constant was temperature, and the author suggests that it is this lack of constancy in temperature and the wide variation between day and night temperature which was primarily responsible for fluctuating milk yields and fluctuating and low fat percentages. The wider the temperature range the greater the depression of milk yield. The author also suggests that an appreciable variation of the minimum fat percentage is noticeable during periods of wide temperature range. He is of opinion that the temperature variation over 24 hours is a fruitful cause of morning milk being low in fat under twice daily milking conditions with uneven intervals.

Flavour Development in Market Milk. *Tracy and Ruehe, Jour. Dairy Science, 14* (3), 250.—The authors have found that while a well conceived and effective system of grading milk by the official plate method will result in a raw milk supply of low bacterial count, it will not necessarily guarantee milk of a good flavour. The milk grading programme followed at the University of Illinois Creamery has resulted in a milk supply of very low bacterial count from which it might be concluded that a very high quality was received. Yet among the milks of the 45 producers who supplied the Creamery, cowy and barny odours were common; puckery flavours were present in most samples; a few were tallowy, and some were metallic. On several occasions milk was received which had a medicinal flavour. Experiments and observation showed that pasteurisation in practically all cases eliminated the barn flavours when present in the raw milk, but that puckery flavours as well as those of a medicinal nature were not appreciably affected.

Milk should not be brought into contact with iron or copper surfaces. Benedict nickel may also have a detrimental effect on milk flavour. The development of a tallowy flavour in milk is closely associated with metal contamination.

Chlorine disinfectants when used for the sterilization of milk utensils should be non-corrosive, and all utensils and equipment so treated should be rinsed with uncontaminated water before being brought into contact with the milk. The odour of phenol when present in milk is greatly intensified by the presence of chlorine in the form of sodium hypochlorite.

Irradiation of Milk and Milk Derivatives. *Supplee, Hess et al. Jour. Biol Chem., 91* (2), 773.—It has been repeatedly demonstrated that the antirachitic potency of certain foodstuffs can be materially increased by irradiation with ultra-violet rays. The authors have found that milk irradiated in the fluid form and subsequently dried by the double roller process has marked antirachitic properties. An irradiation period of only a few seconds is sufficient under suitable conditions to activate a particular sample of milk to a high percentage of its potential maximum. This degree of activation is attained without detectable change in taste and odour.

Sterilization of Glass-lined Tanks. *Scales and Russell. Food Indus.*, 3, 120.—Glass-lined tanks such as are employed in the pasteurisation of market milk may be made approximately sterile by the proper use of chlorine disinfectants. Results indicate that glass-lined tanks which have been properly cleaned and rinsed and then sprayed with a chlorine solution containing 225 to 250 parts per million of available chlorine in an alkaline sodium hypochlorite solution will be practically sterile 30 minutes after being sprayed.

ANIMAL BREEDING.

Cattle.

The Number of Daughters necessary to prove a Sire. *By Jay L. Lush.* 1931. *Jour. Dairy Sci., Vol.* 14, *No.* 3, *pp.* 209-220.—During the past few years increasing emphasis has been laid upon the progeny test of sires as a means for the improvement of farm live stock. The use of the progeny test is nothing new. Bakewell of Dishley used it to the fullest advantage. With the exception of a few of the leading breeders the proper value of it does not appear to have been appreciated, at least until recent years. Only in the last ten years have adequate methods been available for combining genetics and statistical procedure to study the usefulness of the progeny test under varying conditions.

In the paper under review Professor Lush sets out to investigate the number of daughters necessary to prove a dairy sire, and the material is taken from a list of bulls which had fifteen or more daughters entered in the Register of Merit of the American Jersey Cattle Club. In his argument Professor Lush leads the writer into the realms of higher mathematics and the "path coefficient" method of analysing correlation coefficients into their component parts as laid down by Dr. Sewall Wright.

Professor Lush draws attention to the difficulties that beset the proper appreciation of the progeny test, which may be due entirely to environmental and nutritional causes and which must be taken into account. He also states that where close inbreeding is adopted the argument must be modified. The more carefully environmental conditions are controlled and made uniform for all the daughters which are to be tested or the better the correction factors which may be used, the more accurate are the results likely to be obtained.

Firstly, on the point as to whether it is sufficient to take the daughters' records without taking into account the records of the dams of those daughters, Professor Lush states that the increase in accuracy by taking into account the yields of the dams is really comparatively small. The use of daughter-dam comparisons in the proper evaluation of the progeny test should make such a test more reliable, but the effect of so doing is less than is generally believed.

Comparing pedigree, performance and progeny test, if the records of three daughters are available this is of as much value as the records of every animal in the pedigree back to three or four generations. In general, the writer states that when there are as many as four to six offspring included in the progeny test, this will be about as accurate as an estimate based on even a more complete pedigree. However, there are sure to arise occasions when sires with good hereditary constitutions are used in herds where their daughters are under conditions of bad husbandry. Under such circumstances the progeny test by itself may not be so reliable a basis for estimating the value of the bull as his pedigree would have been. Professor Lush states most strongly that he cannot see any logical reason for excluding pedigree or the individuality of the bull even if an infinite number of progeny tests were available.

With regard to the number of daughters which must be tested before an adequate proof may be made of the sire, the writer comes to the conclusion that the number five, the figure adopted by the U.S. Bureau of Dairy Industry, is as practical as any other. Certainly it is more accurate than the progeny test based on three or four, while on the other hand the increase in accuracy which would be gained by requiring more than five tested daughters would be large only when there was a big difference as regards environmental conditions.

There are already "on the market" various methods of working out the progeny test. Some of them are based simply on the records of the daughters, others upon the records of the daughters in relation to those of their dams. The one which so far appears to have made headway amongst breeders in this country is the Mount Hope Index, which is based upon the difference between the yields of the daughters and the dams, that difference being used so that the bull gets credit for increasing the yield of his daughters, and on the other hand gets penalized if he decreases it. This Index has been adopted for Guernsey cattle on that island and by one milk recording society in England. A proper appreciation of this test by the dairy cattle breed societies and the publication by them of the performances of the progeny of bulls should undoubtedly effect an improvement in the quality of the dairy cattle of this country.

Incidentally, this work of Dr. Lush shows that as regards pig testing stations, three litter groups of four pigs each from one boar should give an exceedingly good index of the value of that boar.

Dr. Lush concludes by stating that the progeny test is rightly esteemed as one of the most valuable weapons which the breeder has at his command, but he warns his readers to save themselves from disappointment by keeping in mind the principles on which the reliability of the test is based, and thus know how much confidence should be placed in it.

The Inheritance of Body Weight in Relation to Milk Secretion. *By C. W. Turner.* 1930. *Miss. Agr. Exp. Stat. Res. Bull.* 147.—For some time it has been known that the size of a cow has a direct bearing upon the amount of milk she will give in a lactation. A comparison of the changes in body weight and yearly fat production between dams and daughters indicated that Jersey sires can cause significant changes in yearly fat production (either upward or downward) of their daughters as compared with their dams without causing a material increase or decrease in body weight. It was found that for each increase of 100 lb. in body weight of the dams there was an increase of about 16 lb. in the body weight of the daughters. It was also found that there was an increase of approximately 20 lb. in yearly fat production for each 100 lb.

increase in body weight above 342·3 lb. (The same author in a previous paper working with Guernseys found that an increase of 100 lb. live weight was followed by an increase of 20 lb. in butter fat under the same conditions.) The writer gives a formula for a uniform 1,000 lb. body weight as follows—"Add to or subtract from the actual record of fat production 20 lb. fat for each 100 lb. below or above 1,000 lb. body weight."

Probably more interesting to the practical man are the writer's observations on cost of feed for cows of increased body weight compared with the value of the additional 20 lb. of fat so obtained. Evidence is produced which indicates that the greater production of large cows at best only slightly exceeds the cost of obtaining the additional product. It is concluded that the sires whose daughters are above the average for the breed in fat production without exceeding the average in body weight are especially desirable because their daughters are increasing the economy of fat production of the breed.

Consumption and Production of Veal in the United States. 1931. *Armour's Livestock Bureau, Vol.* 11, *No.* 12.—In this letter there is an interesting reference to the dairy population of the United States. Increased efficiency in milk production in that country has made it possible for the consumption of milk per head to increase every year though the number of dairy cows has not kept pace with the growth in the population. For instance, despite the increased consumption of milk, which is due not only to increased per capita consumption but also to increased population, the number of dairy cows and heifers of two years old and over on farms in the United States was actually smaller in the year 1930 than in the year 1925. [*N.B.*—The 1931 figures published subsequently to this letter show a considerable increase to nearly 23 millions.] There are approximately 22½ million dairy cows and heifers since 1915. Since 1920 this number has increased by only a little over one million.

Furthermore, there has been an increase in the number of lactations in the life of commercial dairy cows, thus making a smaller replacement reserve of heifers necessary. This has increased the number of calves for the veal market, and veal production has increased in importance.

The rest of the letter deals with technicalities in veal production and marketing, and stresses the variations in type of veal marketed at different times of the year. A greater number of light milk-fed calves come in the spring, while the medium to strong veal which comes from calves that have followed cows on grass during the summer is greatest during the autumn months.

Blood Lines that have produced Winning Carcases. *By R. S. Stephenson.* 1930. 23*rd An. Meet. Amer. Soc. An. Prod., pp.* 164-167.—It has long been a matter of debate as to whether famous sires of the renowned beef breeds left the ideal butcher's animal. Many studies have already been made of the blood lines which are to be found in the sires of those cattle which have had a good showyard record. To Professor Stephenson goes the credit of extending this. In his study of the offspring of animals which have done well in the carcase competitions at American livestock shows he is able to compare his own results with those obtained by Professor J. C. Holbert in a study which he made of the prizewinning lines of the Aberdeen-Angus breed in America. Professor Stephenson's work relates to the champion lines in the pure bred Aberdeen-Angus which have won the carcase competitions.

During the years 1921 to 1929 the top five animals in both the carcase classes at the Livestock International at Chicago were selected. 75 per cent. of these winners were sired by Aberdeen-Angus bulls.

According as to whether a carcase had been placed 1st or 5th, five or one points were respectively allotted to it. The breeding of the carcase was determined and grouped into classes having a common ancestor which was considered by the majority of the Angus breeders to have added considerably to the Angus breed. These bulls along with others were found to be the source of the blood that produced the winning carcases. The results were as follows :—

Name.	*Entries.*	*Total Score.*
Prince Ito	21	73
Black Woodlawn	17	67
Illiad	14	49
Earl Eric of Ballindalloch	6	21
Earl Marshall	4	16
Gay Lad	3	9
Zaire 15	3	8

It must be pointed out that not a single carcase came from a steer sired by any of the noted bulls. But this was natural, since the sons of such bulls were all very highly valued for breeding purposes. A comparison of these results with those obtained by Professor Holbert in his study of the prizewinning ability of breeding animals shows a remarkable uniformity which is discussed in some detail. Thus the winners in the carcase competition show that the lines which are popular amongst the American Aberdeen-Angus breeders and which are winning in the breeding classes are the lines which also produce the best carcases.

Horses.

Champion Pulling Teams. *By H. F. Moxley.* 1930. *Amer. Soc. An. Prod., pp.* 176-177.—The popularity of the Horse Dynamometer whereby the pulling power of a horse may be measured is in no way diminishing. Rather interest is steadily increasing, and this paper is an interesting story of what one State alone is doing in this way.

During 1930 twenty agricultural shows in Michigan conducted pulling contests before an estimated crowd of 161,000 people. Of 293 teams entered 169 were light-weight, others being heavy draft horses. Good teams are taken long distances to compete at the outstanding contests. During 1930 twenty different light-weight teams made tractive pulls greater than their live weight. In this connection it will be remembered that when the dynamometer was first introduced it was not expected that it would be possible to obtain a horse which would be able to make a tractive pull greater than its own weight.

Eight heavy-weight teams made tractive pulls of over 3,000 lb., and raised the world's record from 3,325 to 3,575 lb. The team that did this was a team of grey Percheron geldings weighing 2,880 lb. at the time of their record.

Attention is drawn to the fact that these competitions are stimulating interest in a good type of draft horse, the training of the teams showing proper shoeing, proper fitting of collars, harnessing and driving, and have demonstrated the value of horses to farmers in their daily work.

Pigs.

Swine Inbreeding at the United States Department of Agriculture Laboratories and at the State Experiment Stations. *By Hugh C. M'Phee.* 1930. *23rd An. Meet. Amer. Soc. An. Prod., pp.* 128-131.—The writer reports experiments on the inbreeding of pigs which have been conducted at four centres in the United States. At all four places the results indicate a loss in vigour as a result of inbreeding, and no correlation was found between birthweight and degree of inbreeding. But between weaning weight and degree of inbreeding there was found to be a very close association. It is reported that inbred and outbred pigs weighed practically the same at 60 days of age, and that the difference in time required to reach 225 lb. live weight was about 8 per cent. in favour of the outbred pigs. From the University of Minnesota it was found that there was a reduction in vigour after the inbred pigs had reached 100 lb. live weight. At Beltsville the period of slow growth in inbred pigs began much earlier, being pronounced soon after weaning.

Two investigators reported that one difficulty found in inbreeding work was inability to get certain inbred boars to mate with their full sisters. It is reported that structural abnormalities which have appeared amongst the inbred pigs have been rather rare at Minnesota; only one cryptorchid was produced though a number of unusual sex types occurred. At Beltsville the only defect met with was a cleft palate, and this line died out.

Sheep.

Some Observations on the Œstrual Cycle in the Sheep. *By Fred F. M'Kenzie and Ralph W. Phillips.* 1930. *23rd An. Meet. Amer. Soc. An. Prod.*—These observations were made at the Missouri Agricultural Experiment Station during the breeding seasons 1929 and 1930. Pure bred Shropshires, Southdowns and Hampshires were used. There were 97 ewes and in addition 25 ewe lambs. Teaser rams with chalked breasts and aprons ran with the flock. A man gave his full time to making observations and keeping records. The breeding season began about the last day of August, the Hampshires, as a rule, coming into œstrum about ten days ahead of the other two breeds.

The signs of œstrum are described as well as the effect of nutrition. The only constant sign was the behaviour of the ewe with the ram. It was, on the average, 52 minutes from the first signs of heat until they were receptive. The duration of œstrum varies with individuals, the average being, in this case, 26·8 hours. Only 3 per cent. of all œstrum periods were less than nine hours or more than 48 hours. The shortest period observed was five hours and the longest 50 hours. In the lambs the average was 19½ hours and the extremes eight and 41 hours.

As regards the different breeds, the duration of œstrum for the Hampshire, Shropshire and Southdown was respectively 30·7, 26·3 and 24·0 hours, a longer period for the Hampshire being mathematically significant as compared with the other two breeds. The length of the interval from the first of one œstrum until the first of the next œstrum varied with the individuals, but the intervals were remarkably constant in 92 of the 116 periods observed. It ranged from 14 to 16 days in length.

As regards the best time in which to breed, all the ewes were bred at one of three stages in œstrum, during the first six hours, from six to 14 hours, or after 14 hours from the beginning of œstrum. When mated to rams of only fair fertility 70 per cent. of ewes bred after the fourteenth hour of œstrum, while only 35 per cent. of the ewes bred before that hour conceived. When a highly fertile ram was used these percentages rose to 100 and 66 respectively. Hence the writers conclude that it is important to breed in the latter part of œstrum. A day's starvation period during the early part of the breeding season had no noticeable effect on the onset of the first œstrum of the season.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in March, April and May, 1931.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(*Compiled from Returns received from the Department's Market Reporters.*)

Description.	MARCH.			APRIL.			MAY.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*CATTLE—	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*	per cwt. *s.* *d.*
Aberdeen-Angus ...	55 5	46 7	42 3	56 3	46 10	42 0	57 3	48 0	42 0
Cross-bred (Shorthorn)	51 10	44 3	35 8	52 9	44 11	36 4	53 8	45 7	35 10
Galloway	50 5	46 5	...	51 6	46 10	..	54 0	49 2	...
Ayrshire	51 3	39 3	29 3	51 0	39 2	29 0	51 3	41 0	28 9
Blue Grey	...	...	...	...	...	...	57 0	...	...
Highland	...	...	...	...	...	...	...	...	...
	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
†VEAL CALVES	17	9	...	16½	9	...	16	9	...
	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†SHEEP—	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Cheviot	11¾	9¾	8½	12¾	10½	9¼	13½	11½	9½
Half-bred	11¼	10	8	12¼	11¼	8½	13	12	9
Blackface	11½	10¼	8¼	12½	11	9	13	11¾	9¼
Greyface	11¾	10½	8½	12¾	11¼	9¼	13½	12	9½
Down Cross	11½	10½	7¾	12¼	11¾	8	13	12¼	7½
†PIGS—	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*	per stone. *s.* *d.*
Bacon Pigs	11 10	10 9	...	11 3	10 0	...	11 1	10 2	...
Porkers	13 2	12 0	...	12 8	11 3	...	12 2	11 3	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	MARCH.			APRIL.			MAY.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	15 11	12 10	...	18 2	13 17	11 6	17 10	14 1	12 4
Two-year-olds ...	21 12	17 11	...	22 7	17 4	15 9	23 1	17 18	15 11
Cross-bred (Shorthorn) :									
Yearlings	15 5	12 4	10 0	15 14	12 12	11 2	15 17	13 5	11 5
Two-year-olds ...	20 16	16 7	...	21 5	16 7	14 10	21 8	16 16	14 15
Galloway :									
Yearlings	14 15	12 0	...	15 12	11 10	...	15 4	...	...
Two-year-olds ...	19 0	16 13	...	23 3	18 18	...	22 3	17 10	...
Ayrshire :									
Yearlings	12 0	...	...	11 13	10 15	...	12 7	10 5	...
Two-year-olds ...	...	...	...	18 5	15 10	...	17 10	13 10	..
Blue Grey :									
Yearlings	...	...	...	...	...	...	...	14 10	10 10
Two-year-olds ...	...	...	...	37 10	...	...	...	18 5	14 10
Highland :									
Yearlings	...	...	...	...	...	...	10 5	8 0	...
Two-year-olds ...	...	...	...	...	...	...	15 10	12 15	11 0
Three-year-olds ...	...	...	...	...	...	...	19 0	16 0	14 5
DAIRY COWS—									
Ayrshire :									
In Milk	27 3	20 4	12 0	26 0	16 12	12 0	24 6	18 3	12 5
Calvers	25 15	19 15	14 6	25 19	19 10	14 6	25 16	19 9	14 5
Shorthorn Cross :									
In Milk	30 19	23 18	...	29 16	22 11	...	30 4	22 11	...
Calvers	27 15	20 0	15 12	28 14	20 16	14 17	27 10	19 18	13 15
SHEEP—	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cheviot Hoggs ...	42 9	29 9	...	43 3	33 4	...	42 0	30 11	...
Half-bred Hoggs ...	46 6	36 11	...	58 6	44 10	...	59 2	40 3	...
Blackface Hoggs ...	29 1	23 2	15 3	32 2	23 2	18 7	39 2	25 2	21 5
Greyface Hoggs ...	38 7	32 0	26 5	45 2	35 9	31 11	47 5	37 7	32 9
Down Cross Hoggs	...	...	...	...	...	...	...	...	...
PIGS—									
(6 to 10 weeks old)	36 9	24 8	...	34 11	23 0	...	33 0	21 4	...

DEAD MEAT : Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	MARCH.			APRIL.			MAY.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
BEEF :—		per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*	per lb. *d.*
Home-fed—										
Bullock or Heifer ...	1	8¾	8¼	9⅛	8⅝	8⅜	9⅛	8½	8⅝	9⅜
	2	8¼	...	8½	8⅛	...	8½	8	...	8⅝
Bull	1	7¼	6⅝	6¾	7⅜	6¼	6½	7⅜	6½	6⅛
	2	6¾	6	6	6⅝	...	6	6⅜	...	5⅝
Cow	1	6	5⅜	5⅞	5⅞	5½	5¾	5⅝	5⅝	6
	2	5¼	...	5	5⅛	...	5	4⅞	...	5
Irish—										
Bullock or Heifer ...	1	...	...	8	...	...	8⅛	...	...	8½
	2	...	...	7	...	...	7⅛	...	...	7½
Argentine Frozen—										
Hind Quarters ...	1	4⅞	5⅞	...	4⅝	5¾	...	4⅜	5½	..
	2	4½	4	...	4⅜	3¾	...	...	3⅞	...
Fore ,, ...	1	3⅝	3⅞	...	3¼	3½	...	3⅛	3½	...
	2	3¼	3⅛	..	3	3	...	...	2¾	...
Argentine Chilled—										
Hind Quarters ...	1	6⅜	6⅛	6⅜	6⅜	6¼	6	6½	6⅝	6
	2	5¾	5⅜	5⅞	5½	5⅜	5½	5½	5⅝	5½
Fore ,, ...	1	3⅞	3¾	3¾	3⅝	3¼	3	3½	3½	2¾
	2	3½	3¼	3⅜	3⅛	2¾	2⅝	2½	2⅞	2⅜
Australian Frozen—										
Hind Quarters ...	1	...	...	4¼	...	...	4¼	...	...	4¼
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	3¼	...	...	3¼	...	...	3¼
New Zealand Frozen—										
Hind Quarters ...	1	...	...	4⅛	...	...	4⅛	...	...	4⅛
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	...	3¼	...	...	3¼	...	...	3¼
	2	...	...	...	...	...	...	...	...	...
MUTTON :—										
Hoggs, Blackface ...	under 60 lb.	12	10	11	11⅜	11¼	12	11	12½	12¾
	60 lb. & over	11	...	10	11	...	10½	...	...	11¼
,, Cross	under 60 lb.	12	10	11	11⅜	11¼	12	11	12½	12¾
	60 lb. & over	11	...	10	11	...	10½	..	...	11¼
Ewes, Cheviot	1	...	7	7⅞	...	7½	8⅞	...	6⅞	9⅝
	2	...	...	7⅜	...	...	8⅜	...	...	9⅛
,, Blackface ...	1	8	7	7⅞	7¾	7½	8⅞	7½	6⅞	9⅝
	2	7	...	7⅜	6¾	...	8⅜	6½	...	9⅛
,, Cross	1	6	7	7⅞	6	7½	8⅞	6	6⅞	9⅝
	2	5	...	7⅜	5	...	8⅜	5	...	9⅛
Argentine Frozen ...	1	...	...	4	...	...	4	...	...	4
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	4½	3⅝	...	4¾	3¾	...	4⅞	3¾
	2	...	3	...	...	3	...	...	3⅝	...
New Zealand ,, ...	1	...	...	4½	...	...	4½	...	...	4½
	2	...	...	4¼	...	...	4¼	...	...	4¼
LAMB :—										
Home-fed	1	...	...	11½	...	20½	13½	...	17	18
	2	...	...	10¼	...	...	10⅝	...	...	12¾
New Zealand Frozen ...	1	...	7⅜	7⅜	...	7⅜	7¼	...	7⅜	7¼
	2	...	6⅞	...	...	6¾	...	...	7	...
Australian ,, ...	1	...	...	6⅛	...	...	6¼	...	...	6⅜
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	5⅞	...	...	5	...	...	5⅛
	2	...	...	...	...	...	4½	...	...	4¾

EGGS: Monthly Average Wholesale Prices at Aberdeen and Glasgow.

PROVISIONS: Monthly Average Wholesale Prices at Glasgow.

(*Compiled from Returns received from the Department's Market Reporters.*)

Market.	Description.	Quality.	March.	April.	May.
			s. d.	*s. d.*	*s. d.*
Aberdeen.	Country ... ... per doz.	1	1 3	1 0	1 0
		2	1 2	0 11	0 11
	Duck ... ... ,,	1	1 6	1 2	1 0
		2	1 5	1 1	0 11
Glasgow.	Country ... ... per doz.	1	1 4	1 1	1 1
		2	1 3	1 0	0 11
	Irish ... ... per 120.	1	11 5	9 10	10 2
		2	10 10	8 10	8 10
	,, (Duck) ... ,,	1	12 9	10 4	9 2
		2	12 3	8 11	8 11
	Belgian ... ... ,,	1	10 3	8 10	8 5
	Chinese (Duck) ... ,,	1	...	7 3	...
	Danish ... ... ,,	1	11 2	8 9	...
	Polish ... ... ,,	1	8 1	7 2	6 9
		2	6 6	6 1	5 11

Description.	Quality.	March.	April.	May.
		s. d.	*s. d.*	*s. d.*
BUTTER:				
Irish Creamery ... ... per cwt.	1	...	...	111 6
,, ,, (Unsalted) ,,	1	...	...	115 6
Australian ... ... ,,	1	127 0	115 7	113 6
Danish ... ... ,,	1	141 3	126 7	122 3
,, (Unsalted) ... ,,	1	146 3	131 7	126 9
New Zealand ... ... ,,	1	127 0	116 9	114 3
,, (Unsalted) ... ,,	1	185 6	...	...
Swedish ... ... ,,	1	134 3	124 5	117 9
CHEESE:				
Cheddar ... ... ,,	1	93 6	94 0	92 6
	2	82 0	82 10	81 6
Cheddar Loaf ... ... ,,	1	102 0	102 0	102 0
Dunlop ... ... ,,	1	89 0	89 0	87 9
	2	84 3	84 5	83 6
Canadian... ... ... ,,	1	84 3	84 0	84 0
New Zealand (Coloured) ,,	1	66 0	60 10	57 0
,, (White) ,,	1	64 0	59 7	55 9
HAMS:				
Irish (Smoked) ... ... ,,	1	147 0	153 0	162 0
	2	132 0	138 0	147 0
American, Long Cut (Green) ,,	1	77 6	87 0	88 0
,, Short Cut ... ,,	1	77 3	79 5	77 9
BACON:				
Ayrshire (Rolled) ... ,,	1	116 0	116 0	115 6
Irish (Green) ... .. ,,	1	110 0	107 2	104 0
,, (Dried or Smoked) ,,	1	118 0	114 5	110 0
,, (Long Clear) ... ,,	1	104 0	108 5	107 0
Wiltshire (Green) ... ,,	1	118 6	116 5	115 0
,, (Dried or Smoked) ,,	1	127 6	124 5	122 6
Danish, Sides ... ... ,,	1	73 0	81 0	78 0
Dutch, Green (Wiltshire Style) ,,	1	63 6	72 2	64 0
American (Short Clear Backs) ,,	1	84 0	...	...

FRUIT AND VEGETABLES: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.		Quality.	MARCH.	APRIL.	MAY.
FRUIT:—					
Apples—			*s. d.*	*s. d.*	*s. d.*
Irish (Cooking)	... per cwt.	1	17 4	...	...
American ...	... per case.*	1	...	...	12 2
American ...	... per barrel.†	1	38 6	36 11	40 0
Australian ...	... per case.*	1	...	‡10 6	12 1
Canadian ...	... ,, ,, *	1	12 8	12 2	...
New Zealand	... ,, ,, *	1	...	...	14 0
Pears, Californian	... per 46 lb.	1	13 11	12 5	13 4
VEGETABLES:—					
Beet	... per cwt.	1	6 0	5 7	5 0
Brussels Sprouts	... ,,	1	28 0	...	...
Cabbage, Coleworts	... per doz.	1	1 0	1 5	1 5
,, Savoy ...	... ,,	1	1 11	2 3	...
,, Red ...	... ,,	1	2 6	2 10	...
Carrots	... per cwt.	1	4 3	4 0	4 6
Cauliflower—					
Broccoli, Cornish	... per doz.	1	4 8	4 7	4 6
Other British	... ,,	1	...	...	3 2
Dutch ...	... ,,	1	...	...	5 0
French ...	... ,,	1	4 7	4 8	4 0
Italian ...	... ,,	1	5 4	5 3	...
Celery	... per bunch.	1	1 5	1 3	...
Cucumbers ...	... per doz.	1	9 4	7 7	6 9
Greens	per 120 heads.	1	10 0	10 0	...
Leeks	per doz. bunches.	1	4 0	3 8	3 2
Lettuce, Cos ...	... per doz.	1	3 0	2 9	1 6
Onions, *Spring* ...	... per bunch.	1	0 5½	0 5¾	0 4
,, *Dutch* ...	... per bag.§	1	5 6	3 8	...
,, *Egyptian*	... ,, ,, §	1	11 9	8 10	13 9
,, *Valencia*	... ,, case.**	1	9 9	7 11	7 3
Parsley	... per cwt.	1	25 0	22 10	11 6
Parsnips	... ,,	1	7 0	7 0	6 6
Radishes	per doz. bunches.	1	3 9	1 7	1 6
Rhubarb	... per cwt.	1	39 0	27 10	3 5
Spinach	... per stone.	1	4 0	4 0	4 0
Tomatoes, *Scottish*	... per lb.	1	...	...	1 4
,, *Channel Islands*	,,	1	...	2 5	1 2½
,, *Canary*	... ,,	1	0 6	0 5½	0 6
,, *Dutch*	... ,,	1	...	..	0 9½
Turnips	... per cwt.	1	2 2	2 0	2 5

* 40 lb. (approx.). † 10 stone. (approx.). ‡ 36 lb. (approx.)
§ 1 cwt. (approx.). ** 9 stone (approx.).

POTATOES : Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	First Earlies.	Second Earlies.	Late Varieties. Red Soils. Golden Wonder.	Late Varieties. Red Soils. Other.	Late Varieties. Other Soils. Golden Wonder.	Late Varieties. Other Soils. Other.
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
		MARCH.					
Aberdeen, per ton	1	...	...	...	...	7 12 6	5 14 5
Dundee ,,	1	...	...	...	...	...	5 11 3
Edinburgh ,,	1	...	...	...	...	7 10 0	5 18 9
Glasgow ,,	1	...	5 6 8	8 2 6	...	7 1 3	5 10 0
		APRIL.					
Aberdeen ,,	1	...	...	...	...	8 8 0	6 12 6
Dundee ,,	1	...	...	...	...	...	7 1 0
Edinburgh ,,	1	...	...	...	...	9 0 0	7 18 0
Glasgow ,,	1	...	6 7 6	...	...	8 11 0	6 17 8
		MAY.					
Aberdeen ,,	1	...	...	...	...	8 15 8	7 1 3
Dundee ,,	1	...	...	...	...	...	7 10 0
Edinburgh ,,	1	...	...	...	...	9 0 0	7 15 0
Glasgow ,,	1	...	...	...	...	8 10 0	6 17 6

ROOTS, HAY, STRAW AND MOSS LITTER : Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	Roots. Carrots.	Roots. Yellow Turnips.	Roots. Swedes.	Hay. Rye Grass and Clover.	Hay. Timothy.	Straw. Wheat.	Straw. Oat.	Straw. Barley.	Moss Litter.
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
		MARCH.								
* Aberdeen, per ton	1	...	...	...	87 6	...	...	49 5	...	...
¶ Dundee ... ,,	1	...	...	22 0	90 0† 75 0‡	...	...	70 0	...	56 0§
¶ Edinburgh ,,	1	...	...	...	90 0† 82 6‡	...	58 2	58 2	50 0	...
‖ Glasgow ,,	1	...	...	...	75 0†	80 0†	45 0	42 6	...	33 9**
		APRIL.								
* Aberdeen ,,	1	...	...	...	86 0	...	...	50 0	...	...
‖ Dundee ... ,,	1	...	...	20 0	94 0† 80 0‡	...	70 0	70 0	...	56 0§
¶ Edinburgh ,,	1	...	...	...	90 0† 82 6‡	...	57 6	57 6	50 0	...
‖ Glasgow ,,	1	...	...	...	75 0†	80 0†	45 0	42 6	...	33 9**
		MAY.								
* Aberdeen ,,	1	...	...	...	88 9	...	...	46 8	...	...
‖ Dundee ... ,,	1	...	...	18 0	95 0† 81 3‡	...	70 0	70 0	...	52 6††
¶ Edinburgh ,,	1	...	...	...	90 0† 86 3‡	...	57 6	57 6	50 0	...
‖ Glasgow ,,	1	...	...	...	75 0†	80 0†	45 0	42 6	...	33 9**

* Loose, ex farm. ‖ Baled straw, delivered. ¶ Bunched straw, delivered.
† Baled and delivered. ‡ Loose, delivered. § Foreign, delivered in town.
** Home, in 1½ cwt. bales. †† Foreign, ex-quay.

FEEDING STUFFS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	MARCH.		APRIL.		MAY.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	9 5 0	8 17 6	8 16 6	8 6 0	8 7 10	8 1 3
Foreign	8 15 0	...	8 9 9	...	8 2 6	...
Soya Bean Cake ...	9 0 0	8 10 8	9 0 0	8 9 0	9 0 0	8 6 3
Decort. Cotton Cake	8 0 0	...	...	...	...	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	5 0 0	...	4 19 0	...	...
Egyptian (do.)	5 13 5	5 12 6	5 15 6	5 19 0	5 10 8	5 8 9
Palmnut Kernel Cake	7 10 0	...	7 10 0	...	...	...
Coconut Cake ...	8 5 0	...	8 9 0	...	8 10 0	...
Groundnut Cake, Undecorticated—						
(36-37 per cent. Oil and Albuminoids)	5 4 1	...	5 4 0	...	5 5 0	...
(39-40 per cent. do.)	5 2 6	...	5 8 0	...	5 10 0	...
Maize Germ Cake—						
Home	8 15 0	...	8 4 6	...	8 5 0	...
Foreign	7 0 0	...	...	...	...	...
Maize Germ Cake Meal	5 14 5	...	5 19 6	...	5 17 7	...
Rice Meal	4 5 0	4 5 0	4 5 6	4 5 0	4 7 6	4 5 0
Bean Meal	9 12 6	9 3 9	9 14 6	9 6 0	9 15 0	9 2 6
Barley Meal ...	5 13 2	5 10 0	6 3 6	5 17 0	6 7 6	6 2 6
Fish Meal	18 5 0	18 0 0	17 16 6	17 18 4	17 7 6	17 0 10
Maize Meal—						
Home-Manufactured	6 2 6	5 18 9	6 12 0	6 7 0	6 14 5	6 8 9
South African—						
(Yellow) ...	6 1 3	5 12 6	6 9 6	...	6 1[illegible] 0	...
(White) ...	5 17 6	...	6 0 0	...	...	...
Locust Bean Meal ...	6 10 0	5 14 5	6 10 6	5 13 6	6 14 5	5 18 9
Maize Gluten Feed (Paisley) ...	5 15 0	...	6 1 0	...	5 17 6	...
Maize—Plate ...	5 3 2	4 19 5	5 12 9	5 9 0	5 13 9	5 8 2
Do. African, Flat	6 1 8	...	6 10 0	...	...	5 15 0
Oats—Home ...	7 12 2	5 19 5	7 12 0	8 0 0	7 18 5	8 0 8
Do. Plate ...	4 9 5	4 5 0	4 13 6	4 10 0	5 1 7	...
Do. Russian ...	...	4 15 0	...	6 0 0	...	...
Do. Chilian ...	...	...	...	...	...	5 10 10
Barley Feeding (Home)	4 15 11	5 5 0	5 2 6	5 4 0	5 7 10	5 6 3
Do. Bran ...	6 0 0	...	6 0 0	...	...	...
Wheat—						
Home	7 5 0	5 15 0	6 16 0	5 12 0	6 15 8	5 18 9
Poultry	5 15 0	...	5 10 6	...	5 10 0	...
Imported... ...	6 5 11	5 12 6	6 0 3	...	6 8 2	6 5 0
Middlings (Fine Thirds or Parings)	6 1 3	5 7 6	6 1 3	5 15 0	6 1 3	5 16 3
Sharps (Common Thirds) ...	5 0 4	5 2 6	5 5 6	5 10 0	5 5 8	5 7 6
Bran (Medium) ...	5 15 8	5 13 2	5 19 9	5 15 6	5 11 7	5 7 6
,, (Broad) ...	6 1 11	6 13 2	6 2 3	6 13 6	5 14 1	6 7 6
Malt Culms... ...	4 1 3	3 13 2	4 1 0	3 7 6	3 19 1	3 11 3
Distillery Mixed Grains—Dried	...	6 8 9	...	6 17 6	...	...
Brewers' Grains—						
Dried	5 5 4	5 5 0	5 6 7	...	5 13 2	5 5 0
Distillery Malt Grains —Dried	6 7 6	...	6 5 9	...	5 17 6	...
Crushed Linseed ...	18 0 0	...	18 0 0	...	18 0 0	...
Locust Beans, Kibbled and Stoned	5 5 8	4 18 9	5 6 6	4 18 6	5 13 9	5 9 5
Beans—English ...	8 4 8	...	8 3 9	...	8 2 6	...
Do. China	8 17 2	8 9 0	9 0 0	8 10 0	8 19 8	8 10 0
Do. Rangoon (White)	...	...	6 5 0	...	6 5 0	...
Pease—China (White)	7 7 6	...	7 6 8	...	...	...
Feeding Treacle ...	6 0 0	6 10 0	6 0 0	6 10 0	5 5 0	5 7 6
Linseed Oil, per gall.	0 3 6	...	0 3 6	...	0 3 5	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	March.		April.		May.	
		Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	%	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Nitrate of Soda * ...	N. 15½	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Sulphate of Ammonia (Neutral and Granular) * ...	N. 20·6	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0
Nitrate of Lime ...	N. 15½	...	9 15 0	...	9 15 0	...	...
Nitrochalk * ...	N. 15½	9 7 0	9 7 0	9 7 0	9 7 0	9 7 0	9 7 0
Calcium Cyanamide †	N. 20·6	8 18 0	8 16 0	8 18 0	8 16 0	8 18 0	8 16 0
Superphosphate ...	P.A. 13·7	2 16 3	2 17 6	2 16 3	2 17 6	2 16 3	2 17 6
,, ...	,, 16·0	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6	3 2 6
,, ...	,, 18 3	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6	3 7 6
Ground Mineral Phosphate ‖	P.A. 26	2 10 0	...	2 10 0	...	2 10 0	...
,, ,, ,, §	,, 26	...	2 10 0	...	2 10 0	...	2 10 0
,, ,, ,, ‖	,, 34	3 10 0	...	3 10 0	...	3 10 0	...
,, ,, ,, §	,, 34	...	3 10 0	...	3 10 0	...	3 10 0
Potassic Mineral Phosphate	P.A. 18 Pot. 9	3 10 0	3 7 6	3 10 0	3 7 6	3 10 0	...
,, ,, ,,	P.A. 21 Pot. 5/6	3 5 0	...	3 5 0	...	3 5 0	...
Kainit (in bags) ...	Pot. 14	¶3 7 6	3 2 6	¶3 7 6	3 2 6	¶3 7 6	3 2 6
Potash Salts ...	Pot. 20	¶3 17 6	3 10 0	¶3 17 6	3 10 0	¶3 17 6	3 10 0
,, ,, ...	Pot. 30	¶5 4 0	4 12 6	¶5 4 0	4 12 6	¶5 4 0	4 12 6
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	¶9 8 6	9 0 0	¶9 8 6	10 10 0	¶9 8 6	10 10 0
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	¶11 8 6	10 10 0	¶11 8 6	10 10 0	¶11 8 6	10 10 0
Steamed BoneFlour	N. 0·8/1·0 P.A. 28/30	4 17 6	4 10 0	5 0 0	4 10 0	4 17 6	4 10 0
Bone Meal (Home)	N. 3·29 P.A. 23	7 10 0	...	...	...	7 10 0	...
,, ,, (Indian)	N. 4 P.A. 20/22	8 0 0	7 5 0	8 0 0	7 5 0	8 0 0	7 5 0
Basic Slag ** ...	P.A. 11	1 19 0	...	1 19 0	...	1 19 0	...
,, ,, ** ...	,, 12	2 1 6	...	2 1 6	...	2 1 6	...
,, ,, ** ...	,, 13	2 4 6	...	2 4 6	..	2 4 6	...
,, ,, ‡ ...	,, 13	...	1 15 0	...	1 15 0	...	1 15 0
,, ,, ** ...	,, 14	2 7 0	...	2 7 0	...	2 7 0	...
,, ,, ‡ ...	,, 14	...	1 17 0	...	1 17 0	...	1 17 0
,, ,, ‡ ...	,, 15	...	2 1 0	...	2 1 0	...	2 1 0
,, ,, ‡‡ ...	,, 15	...	2 13 6	...	2 16 6	...	2.16 6
,, ,, ‡ ...	,, 15¾	...	2 5 0	...	...	...	...
,, ,, ‡‡ ...	,, 15¾	...	2 15 0	...	...	...	...

Abbreviations:—N. = Nitrogen ; Pot. = Potash ; P.A. = Phosphoric Acid.

* Carriage paid in 6-ton lots. † Carriage paid in 4-ton lots.
§ Fine grist 80 per cent. fineness through standard 100-mesh sieve.
‖ ,, 90 ,, ,, ,, prescribed mesh sieve.
¶ Less 5*s*. 6*d*. per ton, ex-quay.
** F.O.R. in 6-ton lots, 80 per cent. citric soluble.
‡ Ex-Grangemouth. ‡‡ 80 per cent. citric soluble.

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THE WEST OF SCOTLAND AGRICULTURAL COLLEGE.

AUCHINCRUIVE DEPARTMENTS.

Principal W. G. R. PATERSON, B.Sc., N.D.A. (Hons.).

ON 10th July 1931 the new premises of The West of Scotland Agricultural College at Auchincruive were formally opened by Their Royal Highnesses, The Duke and Duchess of York, in the presence of a distinguished platform party and an audience of at least 6,000 keenly interested West of Scotland agriculturists.

In his address the Duke said :—

> " This Institution which we have just inspected, and which is, I believe, the most recent and best example of buildings and equipment for agricultural education, is a tribute to the interest which Scottish farmers take in the improvement of their industry. While the present agricultural depression is widespread it is felt a little less deeply in Scotland than in some parts of Britain, and no doubt this happy state of affairs is due to some extent to the opportunities for education which have long existed in the North.
>
> " I understand that The West of Scotland Agricultural College was the first of its kind to be organised in Scotland. Its beginnings were modest but they must have been on sound lines, else the interest which has provided these fine buildings would not have existed. . . .
>
> " We cannot fail to be impressed by the possibilities of the influence which the College may exercise, not only on agriculture, but on every department of our national life. . . . The health of the people and especially of the children . . . depends to a great extent on their having enough of the fresh products of our farms. . . . In this direction alone, not to mention others, the College, by aiding in the ample production of clean milk, is performing a great national service."

The developments which led up to the occasion, briefly summarised, are as follows :—The Dairy School for Scotland was erected at Kilmarnock in 1904, nineteen years after the commencement of dairy instruction in the West of Scotland and fifteen years after the founding of the Scottish Dairy Institute.

At that time it was considered ample for all requirements, but owing to the great progress in methods of handling and treating milk, it had in recent years proved quite inadequate to provide the most modern facilities for education and research. Plans were prepared and estimates obtained for an addition to the School but, as the farm was not the property of the College and was being greatly curtailed in area owing to the extension of new housing schemes, it was deemed expedient to negotiate for the purchase of the land before proceeding to extend the Dairy School.

The negotiations were protracted mainly on account of difference of opinion on such matters as purchase price, feuing value, mineral rights and risks, and while these were still in progress Mr. Hannah of Girvan Mains came forward with an offer to present Auchincruive to the College provided all College Departments, including the Central College, were transferred to that centre.

The offer was very fully considered by the Governors of the College, but on account of the condition attached to acceptance was regretfully declined. They felt that it would be a mistake to transfer the Central College from Glasgow in view of the area it served and the varied nature of its activities.

Thereafter, Auchincruive was offered to the Secretary of State for Scotland for the purposes of Education and Research, and an arrangement, acceptable to all concerned, was ultimately arrived at whereby part of the estate of Auchincruive was assigned to the College and, by an excambion, a suitable area adjacent to Auchincruive was also provided for the new Hannah Dairy Research Institute.

To meet Mr. Hannah's wishes the Governors undertook to transfer all departments formerly located at Kilmarnock to Auchincruive, and also to make provision there for short courses in agriculture for the benefit of young farmers.

This arrangement does not affect in any way the Central College in Glasgow, which had its inception in 1886 as a department of the Glasgow and West of Scotland Technical College, but was instituted as The West of Scotland Agricultural College in 1899. In connection with the Central College and concurrently with the developments at Auchincruive, a much needed scheme of extension and reconstruction—the third since the College was instituted—has been in progress and is now nearing completion.

Auchincruive is a place of great natural beauty. It is located within four miles of the town of Ayr and the river of that name flows through the estate. It was closely associated with the most romantic and stirring times of our Scottish history. Sir Duncan Wallace, a relative of the Scottish patriot, resided there and stamped his seal upon the locality. Many traditions still survive linking places in the neighbourhood with his name.

On the death of Sir Duncan Wallace the estate passed to the Cathcart family and remained in their hands for about 200 years.

Richard Oswald, a London merchant, purchased the estate about the middle of the eighteenth century, but it was a brother of his who at first resided there. The London merchant later became known as "Oswald the Peacemaker," having been one of those who signed the Treaty of Peace which concluded the American War. It is interesting to find that another of the Oswalds was so beloved by the tenantry as to be designated "Oswald the Good."

The present mansion house of Auchincruive was built by the Oswalds in 1767 and is a very fine structure in the Adams style of architecture; the interior, likewise, is a beautiful example of the Adams decorative work. The mansion house stands upon rising ground high above the river and is pleasantly surrounded by park lands and well wooded grounds.

The area of land at Auchincruive assigned to the College extends in all to 660 acres and consists of the following:—

Arable land	185	acres.
Permanent pasture land	177	,,
Cut over woodland now under grass	80	,,
Buildings, policy grounds and woods ...	218	,,

The soils of Auchincruive, taken as a whole, are somewhat variable. The dominant one may be said to be a fine deep fertile sandy loam, easy to drain and to cultivate. About one-sixth of the total area is river alluvium, which occurs in two main terraces and shows about 4 feet of fine red sandy loam on a deep bed of gravel.

On the higher ground, such as Peel Hill on the south of the river Ayr, the soil on the ridges is a thin clay loam which passes quickly into a raw sterile subsoil of boulder clay of great thickness. The soil on the lower slopes is for the most part a close grained loam or clay loam rich in fine sand and mainly acid in character, while here and there small washes of clay with peat occur.

The varying soil conditions and the range of arable and pasture land will furnish excellent facilities for experimental and demonstration cropping and grass land improvement.

The various College Departments for which provision has now been made at Auchincruive are:—the Dairy School, the Poultry School, the Horticultural Department, the Bee Keeping Department, the Dairy Research (Milk Production and Milk Utilisation) Departments, the Plant Husbandry Research Department, the Experiment Station and the College Farm.

Dairy School.—The new Dairy School embodies the features now considered essential for the teaching of dairying and is equipped to meet in full the requirements of both farm and factory pupils. Some of the main points of difference between the new School and the former one at Kilmarnock are the increased accommodation, the improved facilities for working, and the extensive installation of modern mechanical equipment. It is now possible to maintain a proper balance between the many aspects of dairying, while the laboratory provision enables students to co-ordinate their practical and scientific observations.

The building is in the form of two crosses united by the milk receiving platform and bridged at their southern ends by the longer two storey administrative block. This block runs from east to west and forms the frontage of the building. On the ground floor are the staff and student rooms and offices, and above, two lecture rooms and chemical and bacteriological laboratories.

Working Dairy.—The centrally situated milk receiving platform is really the pivotal point of the building, as therefrom the milk is distributed to the adjoining sections. Being three storeys in height it forms a structural contrast with the single storeyed buildings on either side, and provides two additional platforms. On the first is the plant for milk pasteurising, &c., and on the second a large tank for water storage. Grouped around it and giving the cross arrangement already referred to are the various units of the working dairy, these being, in effect, miniature factories, each self-contained and capable of autonomous management.

The working dairy with white enamelled ceiling and tiled walls is always clean and cool, the ventilation maintaining a pure atmosphere and a steady temperature. The window and roof lighting are such as to meet fully the varied needs of the different parts of the dairy. Drainage from the various rooms is to the outside of the building, the floor slopes having been arranged accordingly. A duct traverses the building from the boiler house to the west wing and houses the main steam and waste water return pipes. Although underneath the building, it is accessible from a point near the boiler house.

The buttermaking section comprises separating, buttermaking and ripening rooms, also a small cold store and ice-cream freezer conservator. In the separating room two hand and two power separators are in almost daily operation. The churning is generally done by means of hand churns of which there are a large number, but two power churns of different types are also available for use and for demonstration. In addition, there is an electrically-heated starter incubator.

The milk treating section is on the opposite side of the platform and therein provision has been made for the manufacture, on a small scale, of condensed milk, powdered milk and crustless cheese. Alongside this special equipment is a miniature homogenizer for the treatment of ice-cream mixes. In a separate room a large scale compressor and a cold store of factory dimensions have been installed and a scullery equipment with hand and mechanical means of washing and sterilising milk cans, bottles, pipes, &c.

Two pasteuriser holders, one glass lined and the other of anchor coil type, are situated on the platform above the milk receiving one. The milk can be pumped to these holders from both the milk treating and the buttermaking sections.

The Mansion House, now used as a Hostel.

THE DAIRY SCHOOL

After pasteurisation, the milk may gravitate over a brine and water cooler enclosed in a dust proof chamber in the cooling and bottling room on the ground floor, or if to be utilised for cheesemaking, may be discharged directly into the weighing tank on the receiving platform and thence to the vats in the cheesemaking room.

The cheesemaking section consists of hard cheesemaking room, press room and store, three stilton and soft cheese rooms, curing room and two cellars. The hard cheesemaking room is fitted with the usual cheesemaking equipment, a number of vats being lined with stainless steel. The heating of the vats is now done by means of steam drop pipes connected up to the vats by hose pipe, a system which is a great improvement on the old method of carrying and adding hot water.

The other rooms of this section are at right angles to the hard cheesemaking room and link up the working dairy with the administrative block. The press room and store with the curing room above are on the west side of the quadrangle, and opposite these, on the east side, are the stilton and soft cheese rooms. Below the latter are the two cellars. Cheeses on removal from the press room are conveyed by means of an electrically-driven goods hoist to the curing room, a considerable section of which has been fitted up with revolving cheese turners.

The cellars already referred to are used as stores and for the ripening of stilton cheese. In one of them the calorifier of the heating system of the building is placed. Washing facilities are provided by two sculleries in addition to the room for can and bottle washing; the one is used by those engaged in hard cheesemaking and the other by those on soft cheese and buttermaking. Part of one of the sculleries is reserved as a laundry.

The steam supply for the Dairy School is generated by two smoke tube multi-tubular boilers. Three separate systems of piping convey the steam throughout the building, one system being for the heating and the other two for the steam and hot water required in the various rooms.

The large compressor (ammonia) operates on an adjacent brine tank, the brine being circulated as required through the large cold store, the milk cooler and the two pasteuriser holders.

Two small automatic compressors (methyl chloride) operate respectively on the small cold store and freezer conservator and on a 300 gallon water tank in the upper storey above the milk receiving platform. The chilled water from this tank is conveyed by pipe to discharge taps in the buttermaking, separating and cheesemaking rooms.

The water supply for the condensors of the three refrigerating units is conserved by being led into a large tank in the platform tower. Any overflow from this tank gravitates to a submerged tank at the boiler house and is available for the boilers. The waters discharged from the milk coolers and cream coolers, as well as all condensed steam from the various calorifiers, also pass directly to this tank.

Poultry Department.—The section of the estate devoted to poultry keeping is situated near the main entrance gate and embraces in all about 20 acres of land. The ground is on a gentle rise and was utilised by a former owner of Auchincruive as a training course for racehorses. It is overlooked by a circular tower termed "The Temple," from which a very fine view of the poultry farm and of the surrounding country may be had. This tower is now utilised as a large tank for the storage of water.

The administrative poultry buildings face the main avenue. They consist of general and private offices, lecture, demonstration, incubator, egg grading, plucking and trussing rooms, food store and mixing room. The large demonstration room is used for indoor work of a practical nature, carpentry for example, being included in the students' curriculum.

The incubator room takes up one complete side of the buildings, and therein are to be seen incubators from the diminutive oil fuel type to the latest electric cabinet machine with a capacity for almost 3,000 eggs.

Immediately behind the main building is a brooder house of modern design. It is sectioned off for stock of varying ages, contains a room for types of indoor and battery brooders, and is equipped with all conveniences for the handling of young stock. Vita glass has been used in one half of the building and ordinary glass in the other. Near the brooder house a considerable area of ground is reserved for the rearing of chicks.

Another section of the land is laid out as follows:—a main avenue intersected with lateral avenues at right angles leads to poultry houses of varying design and so placed that no particular design may have advantage of position.

The first section consists of 56 houses, 8 ft. × 8 ft., which are used for growing and breeding stock and for experimental work in feeding and breeding. The second section consists of eight houses, 15 ft. × 10 ft., with a capacity for 50 adult fowls in each. These are used for laying and breeding stock. The third section contains only four laying houses, 24 ft. × 12 ft., with a capacity for 100 adult fowls in each.

These three sections, which contain in all 68 houses, terminate in an open part of the field in which are placed three large slatted floor houses, the fittings of which are adjustable to suit fowls at any stage of development. A large number of turkeys are also reared and prepared for Christmas on this part of the poultry farm.

At the present time the stock kept is representative of the main utility breeds of poultry, turkeys and ducks, and includes White Leghorns; Rhode Island Reds; Barred and Buff Rocks; Light Sussex; Barnevelders; Faverolles; Buff Orpingtons; Sex-link crosses, e.g. Brown Leghorn cross Light Sussex and Black Leghorn cross Barred Rock; Aylesbury and Khaki-Campbell ducks and American Bronze turkeys.

Horticultural Department.—The gardens extend to about 10 acres and are beautifully situated along the side of the river Ayr.

In adapting them for College purposes every effort has been made to maintain their more prominent features, but several additions and improvements have also been effected. The general lay-out is such as to provide facilities for practical instruction for students in all branches of horticulture, and for experimental and research work in market gardening, tomato growing and fruit cultivation.

The permanent buildings for this section consist of lecture room, students' and staff rooms, working laboratory, office, store, potting sheds, &c.

The glass house accommodation is as follows :—

(*a*) Two tomato houses, 260 ft. and 210 ft. long, for demonstration and experimental work.

(*b*) A fruit range, 200 ft. long, comprising two peach houses, two vineries and one plant house.

(*c*) A propagating house in three divisions, 90 ft. in length, one section of which is glazed with vita glass.

(*d*) A greenhouse, 150 ft. long, divided into three sections and devoted to decorative plants.

The glass houses provide opportunities for instruction in the cultivation of tomatoes, cucumbers, melons, grapes, peaches and nectarines as well as in general greenhouse management. They also furnish opportunity for experimental work with oil as fuel.

The gardens are divided into two more or less distinct sections, experimental and commercial, and ornamental. The latter are peculiarly attractive and extend to between four and five acres, occupying a beautiful natural setting adjacent to the river Ayr. A notable feature in this section is the two massive yew hedges, while between the mansion house and the river is a very fine terrace garden.

Bee - Keeping Department.—The apiary buildings are equipped in the most modern manner, and the department is now in a unique position to train students, investigate bee problems and give invaluable assistance to the entire bee-keeping industry.

The buildings provide demonstration and lecture room accommodation, honey extracting room with special plant, store room, joiner's work room, office and staff rooms.

The demonstration lecture room contains several glass observation hives giving full view of working colonies of bees of different breeds, specimens of honey, wax, pollen, illustrations of bee diseases and of the anatomy and physiology of the honey bee.

The extracting room contains the latest honey extractors, honey ripeners, heather-honey press, wax smelter and honey bottling plant. The joiner's work room and the store room provide accommodation for practical instruction of students in the making of hives and appliances and in fitting these for honey production.

The apiary, which comprises over 100 colonies of bees, is situated in a four acre field with a southern exposure. The field has been converted into a lawn and round the outer edge bee flowers have been planted. The colonies of bees consist of several strains but the predominant one is the old Scotch variety, which has been bred from carefully selected colonies from all parts of Scotland. Various types of hives have been included for educational and research purposes.

Dairy Research Departments.—*Milk Production.*—The accommodation for the Milk Production Research Department has been provided on the former site of the old stables known as Gibbsyard and is thus adjacent to the farm steading. It comprises two offices, a laboratory for milk testing, feed sampling, &c., and a store room. Close to these is a small byre with six stalls specially adapted for feeding experiments with dairy cows.

The main function of this department is to investigate and advise regarding problems connected with the breeding, feeding and management of dairy cattle. Many important feeding problems have been taken up, including the utilisation of home grown foodstuffs and the choice of purchase foods to supplement those grown on the farm, and work along similar lines is being continued at Auchincruive.

The following are some of the feeding problems investigated in the past or now in progress :—the use of succulent foods such as roots, silage or dried beet pulp; the influence of various methods of storage on the feeding value of swedes; the place of roots in the ration; the value of dried potatoes; the relative feeding values of bean meals from different sources and the influence of putting cows out to pasture on the composition of the milk. The amount of protein required in the dairy ration and the most suitable concentrates for cows and rations for calves are also being investigated.

As regards the general management of the dairy herd, the milking machine problem has been studied as well as the control of mammitis and hoven or bloat.

A large amount of work has also been done with the records of the Scottish Milk Records Association, these having been used in the study of factors influencing the yield and composition of milk,—for example, the influence of the age of the heifer at the time of first calving, the age of the cows at the time of calving, the season of calving, the rate of maturity of good and poor cows and similar factors. Certain breeding problems are also being studied with the aid of these records.

Milk Utilisation Department.—The Colin Thomson Laboratories, a particularly fine building for dairy research (milk utilisation problems) has been erected adjacent to the Dairy School and is designed specially for the study of problems relating to milk and its manufactured products.

On the ground floor are located the practical laboratories where experimental work on milk processing, on butter and on cheese can be carried out under controlled conditions. The research laboratories are situated on the upper floor; the main laboratory, where the major investigations will be carried out,

Poultry Administrative Block with Farm Buildings in background.

THE DAIRY BARN.

Dairy Research (Milk Utilisation) Department.

ENTRANCE TO HORTICULTURAL DEPARTMENT.

occupies one end and adjoining it is a smaller laboratory to be fitted with special equipment for the study of milk problems.

A special feature of laboratory construction is the isolation of the inoculating chamber for the handling of putrefactive material. The recent and sudden emergence of a devastating putrefactive taint in farm and factory cheese and the possibility of affected material sent for examination infecting starter cultures issued by the laboratory have made these isolated inoculating chambers essential.

An indication as to the nature and range of the problems which confront the dairy industry and are dealt with by this department may be obtained from a reference to some of the investigations carried out in recent years.—e.g., an extended study of the factors which affect the flavour, keeping properties and sanitary condition of the milk supply; specific defects in market milk; cause and elimination of flat disagreeable flavours in the milk of high producing cows; oiliness in milk; cause of spoilage in commercially sterilised milk; specific methods of detecting abnormally reacting milk; commercial preparation of bacillus acidophilus milk; preparations of rennet solutions from material of local origin; standardisation of rennet extracts; use of selected lactic ferments in the manufacture of hard pressed cheese; slow working in cheese; colour defects in cheese responsible for heavy losses; effect of fore-milk in cheesemaking; an improved method of preparing butter of enhanced flavour and keeping properties; effect of silage and of roots on buttermaking; whipping of pasteurised cream; burnt flavour in dairy products; factors affecting the vitality of lactic acid bacteria in continuous culture; cleaning and care of milking machines.

In addition to these investigations the preparation and issue of between 4,000 and 5,000 pure culture starters per annum is now an important service rendered by this department, and in the new building provision has been made for maintaining the efficiency of this service, a special preparation room being reserved entirely for starter making. Flavour defects in raw and in pasteurised milk is another fruitful field necessitating much research.

Plant Husbandry Department.—The Research Buildings for this department have not yet been erected. It is however anticipated that Plant Husbandry will at an early date be fully equipped, like the other departments, with the laboratories required in connection with the general research work and the field work of this department.

An area, 12 acres in extent, has been set aside for special investigations with the various farm crops and with pasture plants, the main line of work being a study of these crops in health and disease. This work comprises a study of the characters of the varieties of agricultural crops grown in the area served by The West of Scotland Agricultural College and of the diseases which attack such varieties. Many of the diseases met with in the College area have not been studied to the extent their ravages call for, e.g. leaf stripe of oats, which still requires further investigation despite the efficacy of the treatment devised; eelworm disease of potatoes; dry rot and other unknown forms of rot attacking turnips and swedes. These and similar diseases require to be intensively studied with a view to remedial or control measures being discovered and put into operation.

Another important line of work is the selection of strains of varieties of agricultural crops that show resistance to such diseases.

Farm Steading.—The farm buildings are centrally situated near the main avenue and occupy the former site of the stables at Gibbsyard. The major part of the steading is entirely new, but in the scheme of reconstruction the fine frontage of the old premises with central archway and tower has been retained. The archway gives access to a quadrangle which contains the offices of the Milk Production Research Department, the chemical and botanical laboratories, a class room for short course students, a reception room and the farm office. Immediately behind and connected by another archway are located the farm buildings, designed to give the maximum of convenience in working. The main block, which extends right across the steading, includes the barn with threshing machinery, the power room, the granary, straw house, food store, food preparation room, turnip store, and covered weighbridge. Extending the entire length of the block, on the south side, a glass-covered passageway gives access to the dairy byres, the dairy, and to the calf and bull boxes, all of which are at right angles to the main block. Two large hay sheds have been erected alongside the byres and connected thereto by covered passages. The small byre has stalls for 28 cows and 16 young cattle and is of the standard type of the district, with the animals facing the wall, and a central passage. The main byre has stalls for 48 cows and is of the more modern type, having front feeding passages in addition to the central gangway. On the other side of the main block and also at right angles to it there is a range of 14 cattle boxes—seven on either side—each 10 ft. × 10 ft., and with a central feeding passage connecting with a food store, the straw house and the weighbridge in the main block, and also giving access to a hay shed, erected alongside, with lean-to provision for turnip storage. Isolation boxes, stabling for farm horses, with harness room and hay house, cart shed, implement shed, manure store and workshop complete the confines of a large courtyard which has been finished with tar macadam surfaced with tar screenings and will be used for live stock and other demonstrations.

A prominent feature of this courtyard is the large concrete silo 52 ft. high and 15 ft. in diameter erected adjacent to the barn so that the chute may discharge the silage convenient to the dairy byre.

The piggery is an entirely separate and self-contained building with 24 fattening pens, storage for meals and straw, food preparing room, a weighbridge and a killing house. In the construction of the pig pens full scope has been given to the naturally clean propensities of these animals, and the provision of alleys behind the sleeping quarters greatly facilitates the work of cleaning. The semi-circular troughs are white and glazed and a central feeding passage permits of rapid feeding, whilst the wire panel frontage to the pens makes observation easy.

A whey tank has been constructed for the reception of the whey from the Dairy School, whence it is pumped to a smaller tank in the piggery and thus made available for pig feeding.

Throughout the buildings where stock, other than the horses, are housed a uniform system of outlet ventilation has been adopted, namely, the Findlay type of apex ventilator. In the byres inlet ventilation is given by means of Paterson ventilators, whilst in the calf, bullock and bull boxes, as well as in the piggery, inlet ventilation is by means of a series of louvre panels. Additional light to that obtained from the Findlay ventilator has been provided by continuous roof lights on both sides of the byre and piggery roofs.

The calf and yearling boxes have interior divisions of reinforced concrete with tubular iron panels and gates as frontage. The calf boxes are fitted with a device to ensure uniform feeding of all animals in the pens. The byres and feeding pens have been fitted with automatic individual water bowls of a recently introduced type which permit of the stock having access to pure fresh water at all times. The bowls have the additional advantage of being lined with vitrified white enamel that can be readily cleaned. With the exception of the stable, in which some whinstone sets have been used, all floors are of concrete and are vermin proof. In the byres and piggery the beds are insulated with a layer of asphalt to prevent the damp from rising from below, and the passages treated with carborundum to prevent slipping.

All the buildings are electrically lit and an electric motor operates threshing machine, grinding machines, milking machines, &c.

With a view to effecting some economy in labour a Beatty manure carrier is being installed for the two dairy byres, and by this the manure will be conveyed and discharged into a covered dungstead. The liquid manure is conveyed by pipe to a large tank which is at a level that permits of the liquid flowing directly into the liquid manure cart.

The walls of the farm steading in unison with the other departments have been finished externally in cement over a rustic multicoloured brick base, and this, together with the intermingling of the old slates from the demolished housing at Gibbsyard with a green Westmoreland slate, produces a very pleasing effect.

The Hostel.—The mansion house already referred to has, with a minimum of reconstruction, been adapted as a Hostel, capable of accommodating about 80 women students. It is well equipped and provided with all modern conveniences, including electric light and central heating by means of a low pressure circulatory hot water system. There are a few single rooms for the students who prefer these, but many of the larger rooms have been fitted up for two, three or four students. The Hostel also contains exceptionally fine dining rooms, recreation rooms and study rooms.

It has so far not been found possible to provide a Hostel for men students, but no great difficulty has been experienced in obtaining rooms convenient to Auchincruive. By arrangement the men students can have their meals in the Hostel at moderate charges, and this is a great boon for many of the dairy students whose duties necessitate an early start.

Education Facilities.—In conjunction with the Central College in Glasgow, Auchincruive provides facilities for students desiring advanced training with a view to qualifying for a diploma in agriculture, in dairying, in poultry keeping or in horticulture. It affords unique opportunities for degree students, and in particular for those taking honours in certain branches of agriculture. Auchincruive should also prove an admirable centre for highly specialised certificate courses in such subjects as bee keeping, and for courses of a theoretical and practical nature in every branch of farming.

SOME ASPECTS OF THE SUGAR PROBLEM.

A. C. Mason,

Empire Marketing Board.

The raw sugar of commerce is derived from two different vegetable crops, sugar cane and sugar beet. These crops are grown in different parts of the world and hold quite different places in the agricultural economy of the countries where they are grown. The sugar cane is a tropical and sub-tropical plantation crop. The sugar beet is a temperate rotation crop. A sugar estate in the tropics is devoted solely to the cultivation of cane; and the main, practically the sole, object of cultivating sugar cane is the production of sugar. Beet is an incident in rotation farming; when the roots have been lifted, the land is used for a quite different crop. While sugar is among the most valuable of the products obtained, it is by no means the only one. The sugar beet is a plant which provides a great range of by-products, some of which are almost as valuable as the sugar itself—molasses, pulp, tops, lime, cake and a whole host of others, while it is a particularly good element in the rotation of crops. Naturally, two raw materials so different in origin have different parts to play in the world market for the common product; and a good deal of the interest in sugar economics is to be found in the relations between these two dissimilar crops.

Until the Napoleonic era, all the sugar used in Europe was cane sugar, and this was derived from what would now be called a low-yielding variety of cane. The Europeans carried this variety with them to America, and, at the time when the beet industry began, the world's sugar was being derived from canes of this sort and the standard of output was regulated by their yield. It had been known for some time that sugar could be obtained from a variety of beet; in fact, the first crystals had been made (in the laboratory) as early as 1747. A factory for the commercial use of the process was later set up under the patronage of Frederick the Great. Some experiments had already been made in France, when the pressure exercised by the British Navy caused Napoleon to take vigorous measures to create a new sugar producing industry. In 1811 he took the matter in hand to such good effect that within seven years there were over 200 factories at work in France producing 4,000 tons of refined sugar a year between them.

The great sugar producing industry of the West Indies grew up at a time when the whole spirit of agriculture was intensely conservative. Sugar cane was one of those crops which were cultivated in accordance with an established tradition, and its standards were those of the rather easy-going rule of thumb agriculture which flourished at the time when the American industry was being established. Moreover, it was only natural in the circumstances that, since sugar cane was grown by black labour on tropical estates, the practice of cultivation should not vary very much from one generation to another, and that the European owners of the plantations should have little incentive to trouble themselves with a scientific study of their product. This way of going on had been very successful for generations and there seemed no reason why it should not continue indefinitely.

Beet sugar was a scientific crop from the beginning. It was with difficulty and as a curious chemical experiment that Andreas Marggraf produced the first crystals of undoubted sugar from this source. It was due to the science of the time that the plant itself and the handling of its product were sufficiently improved for a small beginning to be made with the industry a quarter of a century later. It was by his favourite mass attack at the critical point that Napoleon overcame the difficulties that stood between France and a useful supply of sugar from home-grown beet; and the troops whom he mobilised for this operation were scientists to a man. His decree of March 1811 devoted 80,000 acres to the cultivation of beet and the selection of the best strains. He was sufficiently confident in the capacity of a rationalised scientific handling of the problem to prohibit the import of sugar from the East and West Indies altogether, and in the next year, just before he left for the campaign of Moscow, he established six experimental schools where the scientific aspects of the new industry were to be studied and the pupils were to be trained in the appropriate theory and practice.

Beet sugar, like so many products of applied science, is thus on one side the child of the French Revolution, and it has been scientifically managed from the very beginning of its career. The mere fact that it is a root crop connects it with a revolutionary break in a long standing agricultural tradition and with the origins of scientific farming in Western Europe. It is not necessary to go into the successive developments which led to the establishment of the beet sugar industry in Europe. By the middle of the nineteenth century, when the standard of life was rising in all western countries as a consequence of the rapid development of industry, and the demand for sugar was consequently expanding every year, beet sugar was steadily increasing its proportion of the total supply.

During the last half of the century the contributions of cane and beet respectively to the world's sugar supply were in the following proportions :—

Percentage of Total World Production.

	Cane.	*Beet.*
1853-4	92	8
1863-4	85	15
1873-4	72	28
1883-4	67	33
1893-4	61	39
1903-4	53	47

Just before the war, sugar cane produced slightly more than half the world's total supply. Since 1903 there had been a slight tendency in favour of cane sugar. This was really the beginning of a movement which was slowly gathering way. For a variety of reasons the States in which beet sugar was produced had protected that crop, either by direct subsidy or by a tariff. In the meantime the scientific study of the crop had proceeded without a break, and great improvements had been made in the sugar yield of the beet and the methods of dealing with the product. Towards the end of the nineteenth century some growers of sugar cane began to realise that their crop also would be the better for a more intensive scientific study; and a certain amount of progress had been made in this direction when a Convention was made at Brussels in 1903 whereby the beet sugar producing States undertook to give no more subsidies, direct or indirect, to the producers of beet sugar. The effect was to put cane once more on equality with beet.

A good deal of activity in the scientific study of cane and the breeding of new varieties of cane and also in the factory technique for the handling of cane sugar was in progress in the decade before the war, and the sugar cane industry was rapidly approaching a state in which it would be ready to make a notable step towards the recovery of its old supremacy when the outbreak of the great war gave it such an opportunity to achieve this end in a short time as could hardly have come about in any other circumstances. The countries whose agriculture was most disturbed by the war were precisely those which produced practically the whole of the world's beet sugar—Germany, Austria-Hungary, Poland, Russia, France, Belgium. Their beet sugar areas were either put out of cultivation by the movement of armies or had to be largely devoted to other crops, while a great portion of the area which was still devoted to beet sugar was inside the ring of the allied blockade, so that practically the whole world, except the Central Powers, had to rely on the sugar cane for its supplies. The gift of practical monopoly in a market where prices are rising continuously and the demand is so great that there is practically no danger of over-production is a tonic which seldom comes the way of any industry. No wonder the war brought about an immense expansion of sugar cane; its effect is seen below :—

World's Production of Sugar. (Million tons.)

YEAR.	TOTAL.	Cane.	Beet.	Percentage of total. (Cane.)	Percentage of total. (Beet.)
1913-14	19·6	10·7	8·9	55	45
1923-24	21·1	15·1	6·0	72	28
1928-29	28·4	18·9	9·5	67	33
1929-30	28·0	18·8	8·2	67	33
1930-31	29·3	17·7	11·5	61	39

While the recovery of so much of its old position by cane sugar under the stimulus of war is remarkable enough, perhaps the rapidity with which beet sugar has made up its lost ground is even more remarkable. As a result of the last campaign, beet sugar is as far forward as it was in 1893-94, and the leeway which it has made up during the last seven years is equivalent to the distance covered in the twenty years between 1874 and 1894.

In the first campaign after the war, the world's production of beet sugar was only 3·3 million tons as against 8·9 million tons in 1913-14. By 1927 beet sugar had recovered its pre-war output, and its production is now some 30 per cent. above 1913-14. There are, however, limits to the extent of this recovery; and it by no means follows that, because the re-establishment of the beet sugar industry has been so astonishingly rapid, the steady proportional increase of pre-war days will be continued indefinitely. Not only has beet numerous difficulties of its own to contend with, but cane has so far improved its yield and reduced its comparative costs that it is in a much stronger competitive position than it has been for half a century.

During the last quarter of the nineteenth century, increasing attention was paid to the scientific side of cane sugar cultivation. The first experimental station to be devoted entirely to cane sugar problems was set up in Java; in fact when the need of research and experiment became urgent towards the end of the 1880's no less than three experimental stations were erected in different parts of the island, and two of these have continued in being to the present day. One specialised in agricultural research and another in the technical and chemical aspects of the industry. In 1907 these stations were brought under the control of an association which was set up for the purpose of managing experiments for the benefit of the Java sugar industry. In 1924 the whole of the work—agricultural, technical and chemical—was concentrated in one group of buildings at Pasoeran in East Java. This is called the Proefstation Oost-Java, or " P.O.J."

A few years after the Java station was established organised experiments began in Mauritius, and ten years later in Hawaii. Following these examples, the scientific study of the crop and particularly the breeding of high yielding and resistant varieties has become general, not only in stations subsidised and controlled by governments, but also on progressive estates in all sugar growing countries. Thousands of cane varieties are being bred every year and the most promising specimens are being selected.

Studies are also being made in the diseases of the sugar cane, its insect enemies, the methods of cultivation, the use of fertilisers, the methods of extracting and clarifying the juice and the use of by-products. At the experimental station proper, thousands of tests of actual plants and samples of soil, fertilisers, juice and so forth are accompanied by researches into the scientific basis, biological, chemical and physical, of the various natural processes which are being subjected to the field tests. The great triumph of the Java station so far has been the production of a disease-resisting cane with a very greatly increased yield of sugar. This, the famous " P.O.J. 2878," is really a hybrid, derived from a local variety of sugar cane and a local wild reed, which in its natural state produces no sugar at all. By these methods the sugar cane as an economic crop has been improved out of recognition, and the studies and experiments which have led to this improvement are being intensively pursued, so that further advances may be made at any time.

In the British Empire all the sugar countries are pushing forward their research work. Cane breeding has made particular progress in Barbados, and the stations in Mauritius and at Coimbatore in India are making notable contributions to current sugar problems.

The general effect of all this progress in the cultivation and handling of sugar cane is that a great deal more sugar can be obtained from the same area than was the case a quarter of a century ago, and the cost of production has been brought down to such an extent that in the most favourable countries it is only about half that involved in the production of beet sugar. Between 1880 and 1902 the output of cane sugar doubled, rising from 2,000,000 tons to something over 4,000,000 tons. In the first ten years after the 1902-3 season, during which the Brussels Convention regarding beet sugar was concluded, the world output of sugar of all kinds increased by over 6,000,000 tons, all of which was consumed. Beet sugar represented 3·6 million tons of this increase and cane sugar of the kind suitable for consumption in western countries 2·5 million tons. At the end of that period came the war, and after the war the succession of economic difficulties which has led to the present situation. In spite of the recovery which beet sugar has made from the devastation of the war period, its output was in the last campaign little greater than it was in the 1913-14 campaign, while the output of cane sugar has been practically doubled once more. Of the 29 million tons of sugar which the world has produced during the current season nearly 17¾ millions are cane sugar.

For some decades before the war, the world's consumption of sugar had been increasing at a fairly steady rate of about 3 per cent. per annum, and the expanding output corresponded to this regular pressure of demand. The term " consumption " does not necessarily imply that the sugar was actually used as a foodstuff. It is really equivalent to " delivery." What are called " consumption " statistics show how much sugar has passed out of visible supply into the hands of consumers and users; some of this may be put into store, especially if the purchaser has any reason to suppose that the price of sugar is likely to rise and to remain high for a considerable time. It is quite impossible to know accurately how much sugar is being held in this way at a given moment, but it may be supposed over a long enough period that the statistics will reveal the general tendency of actual consumption, for the capacity of private stores is limited, and after a time an accumulation of invisible supplies would be bound to have its effect on the market.

When the war came the situation was completely altered, and supplies became short. While the effect of that abnormal period may have been to change the habits of some marginal consumers, its main effect was to build up a large potential demand, which was released as soon as rationing came to an end. When things began to settle down after the war it was seen that the consumption of sugar was rising more rapidly than before, and a figure of 4½ per cent. has been suggested as a measure of this increase. To some extent there may have been a change in habit, partially due to the reaction after the period of rationing and restricted supply; there may also have been a certain amount of sugar put into store; but, on the whole, it seems reasonable to suppose that, for a dozen years after the war, the world's appetite for sugar was increasing more rapidly than its appetite for any other natural or industrial product. This seems to be borne out by the investigations into the production and consumption of commodities carried out by the economic section of the League of Nations in 1927.

It was now that certain effects of the rather belated application of science to the cultivation of the sugar cane began to be apparent. Under the stimulus of war conditions both Cuba and Java had extended their cultivation, and the output per acre and per ton of cane harvested had been notably increased. Even if the beet sugar countries were not in the position to take up their old place as producers for the European market, there was a good prospect of the rapidly increasing world demand being met by cane sugar alone. As it was, however, the beet sugar countries, particularly those of Central Europe, found it desirable to re-establish their industry at the earliest possible moment, both for the purpose of cutting down their imports from abroad and, if possible, for increasing their exports, a necessity which was laid upon them by their situation of debtor countries after the war. This rapid re-establishment of the beet sugar industry in Europe succeeded beyond expectation and, while the producers of Cuba were deciding that the moment had come for them to extend their acreage and obtain a dominating position in a favourable world market where cane sugar would have a practical monopoly, the agriculturists of Germany, Poland, Belgium, Czecho-Slovakia and Hungary were busy remaking their beet sugar crops. Most of the European countries had made up their minds that they would never again be entirely dependent on sugar from abroad; the war had been too sharp a lesson to them; and while the Continental producers were putting their land once more under sugar beet, Great Britain was taking steps to establish a beet sugar industry of her own, thus providing a domestic competitor in one of the world's greatest markets for cane sugar. It was extremely difficult in that time of confusion for anyone to guess what the future had in store and, indeed, for most people to know what was actually being done in the principal countries of the world. It is no wonder that the cane sugar producers misread the situation; even the most hopeful supporters of beet sugar were amazed at the rapidity and completeness with which their industry recovered.

The general effect of these events was that a very greatly increased supply of sugar from all sources became available and much more had to be put on the market than was warranted, even by the extraordinarily rapid increase of consumption. The way in which output ran away from consumption may be seen in the following table :—

World's Production and Consumption of Sugar.

Cane and Beet together. (Thousands of tons.)

Year.	Production.	Consumption.	Excess.	
			Production over Consumption.	Consumption over Production.
1923-24	21,064	21,188	...	121
1924-25	24,531	22,889	1,642	...
1925-26	26,633	24,322	1,811	...
1926-27	24,327	24,487	...	160
1927-28	26,159	26,073	86	...
1928-29	28,423	27,044	1,379	...
1929-30	28,012	26,562	1,450	...
1930-31 (estimated)	29,249	27,100	2,149	...

Quite apart from the amounts which may be held invisibly (which are not likely to be very great at the present time in view of the persistent depression of the market), there is thus a large accumulation of sugar for which no buyers can be found. If production goes on increasing as in recent years, and even if demand does not fall off, this accumulation will get worse. So long as there is such an amount as this unsold it is practically impossible for the world market price to recover. This is the situation which sugar producers had to face at the end of last season.

Some attempts have been made to deal with the increasing disparity between supplies and consumption. Cuba has tried a system of pooling export sugar and approaching its market in the person of a single seller, and control has been attempted also in Java. These and other attempts to manage the disposal of sugar on the market by means of various kinds of trust or cartel were not so successful as might have been hoped as none of them were sufficiently wide in scope to establish a control over world production. The storage capacity of the various exporting countries is naturally limited; and the moment stocks get too big to be contained in the existing warehouses they have to be disposed of on the world market at whatever price they will fetch, regulations or agreements notwithstanding.

In the face of this persistent tendency for supplies to increase more quickly than consumption and the world-wide crisis which resulted from it, the League of Nations called a Sugar Conference in 1929. In a paper which he prepared for this Conference, Dr. Gustav Mikusch of Vienna expressed the view that " the present sugar crisis is undoubtedly due to an excessive increase in production throughout the whole world, since the expansion of world consumption is entirely satisfactory and more rapid than before the war. Production, however, has gone ahead so quickly that since 1924-25 the world production of sugar far exceeds consumption, and thus the stocks, though not excessive, have increased progressively year by year." The outcome of this Conference at Geneva was a strong recommendation that the problem should be dealt with at its source. While this would, of course, entail a restriction of output and would thus necessitate sacrifices on the part of all producing countries, it was felt that in the face of an international crisis of this magnitude it should not be impossible for the principal countries concerned to come to an agreement as to the sacrifices which each should make in the common interest.

While ideas were in this promising but indefinite state, a Cuban-American Committee, representing the leading Cuban producers and Canadian and American banking houses strongly interested in Cuban sugar, were discussing the measures that ought to be taken to improve the position of Cuban sugar in the United States market, and also what could be done to initiate a policy which might be attractive to Java as well as perhaps to other sugar-producing countries. This Committee, under the chairmanship of Mr. T. L. Chadbourne, developed by successive stages into a World Sugar Congress, which, after a long series of meetings at various centres, finally agreed to a plan for the regulation of the raw sugar industry throughout the world and for disposing of the accumulated stocks. A Convention was signed at Brussels on May 9th, 1931, after a very laborious negotiation which had lasted for over eight months.

There are three main parties to the Convention of Brussels each of whom has its own problems :—Cuba, Java, Central Europe. Cuba depends to a very great extent on the United States market, and the persistent low price of Cuban sugar in New York has been a great anxiety to many producers whose financial resources are far from large. Java is in a somewhat different position, having a well-organised industry with a very advanced scientific wing and being the world's cheapest large-scale producer. It might have been expected that Java would hesitate to approve a scheme of restriction, the first benefits of which would go to her great rival. However, the choice was not left altogether free; for India, who used to take a million tons or so of Javanese white sugar every year, has recently decided to protect her own industry so strongly as to make it practically certain that sugar will no longer be imported.

During the negotiations, the European countries (Germany, Czecho-Slovakia, Poland, Hungary and Belgium) all showed readiness to fall in with any reasonable proposal. The Germans, however, were not satisfied with the export quota which was first assigned to them. Finally, a compromise was reached whereby a concession was made to Germany, mainly at the expense of Cuba. As things have turned out, the Germans now find that they will not be able to afford the export of so much sugar at current world prices, which have fallen so far below the level of the protected domestic market that export can only be carried on at a loss. All the parties to the Convention are now satisfied, and Cuba is not much worse off than before.

The dimensions of the world problem are shown in the following table :—

Production and Consumption of Sugar, 1928-29.

	Consumption =				
	Total. (000's of tons.)	Per capita. (lb.)	Output. (000's of tons.)	Import demand. (000's of tons.)	Export surplus.
United Kingdom and Irish Free State ...	2,095	101	215	1,880	...
All Europe including the United Kingdom ...	9,879	41	8,348	2,787	1,256
British India	3,987	27	2,993	994	...
China and Hong Kong...	1,191	6	236	955	...
Java	332	20	3,113	...	2,781
All Asia including the above	6,953	15	8,010	1,949	3,006

	Consumption =				
	Total. (000's of tons.)	Per capita. (lb.)	Output. (000's of tons.)	Import demand. (000's of tons.)	Export surplus.
South Africa	179	46	263	...	84
Mauritius	6	32	270	...	264
All Africa including the above	811	12	800	359	348
Cuba	166	103	5,157	...	4,991
United States and their Dependencies... ...	6,529	118	2,530	3,999	...
Canada and Newfoundland	420	100	32	388	...
British Colonies in America	46	34	361	...	315
Central American countries	312	27	716	...	404
South American countries	1,520	43	1,842	...	322
All America, North and South, and insular ...	8,993	83	10,638	4,382	6,032
Australasia	408	96	627	...	219
WORLD TOTAL ...	27,044	31	28,423	9,482	10,861

The column headed "Per Capita" (Consumption) shows that there is plenty of scope for an increase in the use of sugar in many parts of the world, so that there is every reason for an attempt to be made to bring the market back to a healthy condition, in which it will be worth the producers' and distributors' while to set about providing for this potential demand.

Two problems underlie the agreement finally reached :—

(*a*) the disposal of the existing world surplus in a manner which shall be fair to all the countries concerned, and

(*b*) the restriction of output in the immediate future, so as to prevent any addition to the surplus or the replacement of any part of it that may have been dispersed.

The surplus sugar held in each exporting country has accordingly been segregated, and it has been agreed that only a given amount of this segregated quantity shall be exported each year. When there is an existing arrangement (as between Cuba and the United States), a yearly quota has been assigned to cover these special exports. Domestic consumption has also been taken into account; and the amount which it will be safe for each country to produce during each of the next five years has been estimated by a combination of all these items.

One of the promising factors in the new situation is that, the safe limits of output having been determined, the Governments of the various sugar producing countries are showing their willingness to co-operate in seeing that these limits are respected.

The final allocation of export quotas to the principal countries is set out below :—

Exports. (Thousand tons.)

	1st year.	2nd year.	3rd year.	4th year.	5th year.
Cuba	3,232	3,605	3,655	3,655	3,655
Java	2,300	2,400	2,500	2,600	2,700
Total Cane Sugar ...	5,532	6,005	6,155	6,255	6,355
Czecho Slovakia... ...	571	571	571	571	571
Germany...	500	351	300	300	300
Poland	309	309	309	309	309
Hungary...	84	84	84	84	84
Belgium	30	30	30	30	30
Total Beet Sugar ...	1,494	1,345	1,294	1,294	1,294
Total Cane and Beet Sugar	7,026	7,350	7,449	7,549	7,649

These exports are thus sub-divided :—

	1st year.	2nd year.	3rd year.	4th year.	5th year.
Cuban exports to U.S.A.	2,577	2,800	2,800	2,800	2,800
All remaining Sugars to "free" markets ...	4,449	4,549	4,649	4,749	4,849

In addition, if the price of sugar rises to 2 cents per lb. f.o.b. Cuban port, and remains at that level for 30 consecutive days, the quota available for the " free " markets may be increased by 5 per cent. Each further sustained increase of ¼ cent in the sugar price up to a maximum of 2½ cents involves a similar increase in the total amount that may be exported to " free " markets.

Since these figures cover the chief areas of production and the principal accumulation of stocks, it should be possible, if the scheme is carried out as it now stands, to bring about a gradual improvement of the market conditions. There are, however, many countries which are not parties to this Convention, among them those of the Empire, which produce mainly for the British market. Although in the aggregate their production is considerable, there is no single one of them whose signature to such a Convention would be essential.

There is a danger that, should the Convention attain its object and the world market price of sugar begin to improve, some of the outside producers may be tempted to increase their output and to throw so much fresh sugar on the world's market as to bring the price down again, to the disadvantage of all concerned. It is even possible that some of the signatories themselves may, when they see that the world price at long last shows a definite tendency to improve, regret their precipitate acceptance of desperate remedies and try covertly or openly to get rid of more than they are supposed to do under the strict letter of the agreement. The object of the pact is to assure as speedy a return as possible to an even balance between supply and demand; and any action of this sort would completely upset such a healthy tendency. The operation of the scheme is put into the hands of an International Sugar Council, which is to have its headquarters at the Hague; and, when the price of sugar has reached certain levels (as already mentioned), this Council will be empowered to increase the export quotas of particular countries by agreed amounts. It is thus rendered possible for the countries which have signed the Convention to get the true advantage from any permanent or quasi-permanent increase of price, while the power vested in the International Sugar Council to release extra sugar at its own discretion up to certain specified amounts makes it sufficiently powerful to discourage any outside producers from trying to flood the market with fresh sugar at cut prices. The voting power of the International Sugar Council has been so allocated that no one party or group can dictate future policy.

All this arrangement assumes that the stocks which are thus put under the control of the International Sugar Council represent so great a proportion of the sugar actually existing in the world that the trend of the market can be kept well under control. It remains to be seen, however, whether this assumption is a sound one; for it is possible that the market may be considerably influenced by developments in respect of invisible supplies, which are not, and cannot be, controlled by the International Sugar Council. In the first years after the war, the fear of a continued shortage kept prices at a high level and caused invisible supplies to be steadily built up all over the world. Those who tried to estimate how much sugar was actually being used up, and so how much fresh sugar would be required in future years, had no reliable guide to the amount that was being put into store as an insurance against the effect of still higher prices in the future. A good deal of this building up of invisible supplies was mistaken for actual consumption, and this led to a state of mind favourable to increased production.

The time came when the limit of taking sugar into stock was reached, and more and more of the world's increasing output of sugar was thrown on to the market at once, with the result that prices began to fall; they have been falling ever since. Although there have been a number of false starts towards recovery, there has not been sufficient improvement to warrant a further accumulation of invisible stocks. In fact it seems probable that invisible supplies are at the present moment extremely low; instead of the surplus being held by a large number of concerns all over the world, the greater part of it is held as to white sugar by the refiners and as to raw sugar by the plantations, i.e. by the producers of either product. The future of sugar and the effect of the Sugar Convention depend to a large extent on the degree to which invisible supplies have been depleted and the amount of leeway which will have to be made up when users begin to protect themselves against the risk of being caught on a rising market. One principal effect of the Convention is expected to be the increase of invisible supplies to a more normal figure.

It is very difficult, however, to form an idea of what this term " the normal figure for invisible supplies " ought to mean in actual quantities. There are no regular statistics bearing directly on this point. One estimate, which was made during last October by Mr. M. Golodetz, is built up on the supposed relations between the amounts kept in store by domestic users and those which have to be held by retail distributors, wholesalers, manufacturers and importers. Assuming that, on the average, the amount which is being stored by households throughout the world on any one day is rather more than half a million tons (i.e. a week's supply), Mr. Golodetz arrives at the conclusion that the amount of invisible supplies throughout the world on any one day would be rather more than 7¼ million tons, while in normal times twice this amount would be in existence, in addition to that accounted for in the statistics. More recently, Messrs. Lamborn of New York have put out the opinion that invisible supplies may vary from about 3 million tons in times of great distress, such as the present, to as much as 10 million tons at a boom period. In their opinion the world usually has something like 6½ million tons in this condition.

It is really quite impossible to make anything like an accurate estimate. From a few enquiries which some of the Empire Marketing Board's investigators were able to make it has been strongly suggested that distributors of sugar in this country are buying from hand to mouth and that, while a good number were in the habit of buying supplies fortnightly, monthly or at longer intervals a few years ago, nearly all are now content to replenish their stocks weekly. Too much weight need not be attached to this very small indication, but it certainly tends to show that, as might have been expected, stocks are being kept at the smallest possible level.

If invisible supplies have been so far reduced as Messrs. Lamborn suggest, it is likely that there will be some brisk buying for stock when the world price really begins to improve. It may be that there is such a margin between the present level of invisible supplies and the normal that the releases of extra sugar which may be made by the International Sugar Council will be quite insufficient to meet the pressure of this latent demand. Prices may in fact run away with the market and carry the balance of supply and demand with them. No one can really tell what will happen or how much sugar will have to go into invisible supply before the world situation becomes normal again. No one can even say whether during this time of stress, which has been accompanied by a certain amount of progress in transport and storage facilities, the extent to which invisible supplies are necessary may not have been altered. It is quite possible that, when we come to take stock of the sugar industry after the restoration of stable conditions, we may find that some of the accepted practices have been permanently modified.

Since the above was written in July, the world economic crisis has become much more acute and the arrangement made at Brussels to deal with superfluous stocks of sugar has been subjected to a very severe trial. On the whole, it has been remarkable that, in spite of the numerous economic difficulties which the whole world (and particularly some of the principal sugar producing countries) has had to encounter during this very trying period, the world market for sugar has, after a little initial hesitation, remained fairly steady. It might have been thought that the economic difficulties of Cuba, a part of whose segregated quota is earmarked by agreement for the United States market, might have led to a breach of the Convention. On this side of the Atlantic, Germany, who is one of the principal exporters of beet sugar, is the very storm centre of the financial and economic crisis. There is no doubt that there has been a very real danger of Germany being forced to unload on the world market the greater part, or the whole, of her segregated stocks. If Germany had been forced to act in this way, it would not have been long before Czecho-Slovakia and Poland followed her example. On the other side of the world, the beneficial effect of the Brussels Convention has been held back by persistent stagnation in the market for Java white sugar. The United Java Sugar Producers' Association has been compelled recently to sell the remaining quarter of a million tons of the 1930 crop at a low price. Fears have been expressed in Amsterdam that Java might be compelled to throw even more of its segregated stocks on to the market, owing to the difficulty of financing its holdings. This fear, however, would seem (for the present at any rate) to have been exaggerated.

If there had been no intensification of the world depression the persistent difficulties of the sugar industry in the three principal parts of the world might have been taken as a very discouraging symptom, but the most important fact so far is the maintenance of the Chadbourne plan intact. The fact that the scheme has come through this extremely difficult period successfully is good and heartening evidence of its original soundness for its special purpose. Though its full effect has not yet been felt, and though, as a result of recent events in world economics, its early effects have been to some extent deferred, there can be little doubt that real progress has been made towards placing the world's sugar industry on a sounder economic basis and that an effectual corrective has been found for the unhealthy condition of statistical disequilibrium. Unless the operation of forces outside the control of the world's sugar industry completely upsets present calculations, it seems likely that the gradual adjustment of supply and demand, which was the purpose of the scheme, will be successfully brought about. Considerable amounts of sugar are being kept out of the world market; most of the growers have taken effectual measures to restrict production within the limits prescribed by the plan; and the industry may, therefore, look forward with confidence to a period of more stable conditions.

As regards the Empire sugar industry, possibly the most important event of recent months has been the holding of the first Imperial Sugar Cane Research Conference. Representatives of all the sugar growing countries in the Empire assembled in London during the latter part of July and questions relating both to the economic state of the industry and to the possible co-ordination of research measures were discussed.' The resolutions passed by the Conference include a number of recommendations aiming at closer co-operation in the application of scientific research to sugar cane problems throughout the Empire.

ON THE TRACK OF THE HARMFUL INSECT.

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Insects and the Farm: Some Benefactors.—Insects are, most of them, insignificant creatures, and man's tendency is to ignore whatever does not thrust itself upon his notice. I wonder, therefore, if anyone can realise the magnitude of the part played by insects in the running of the farm. Their importance depends upon their numbers, for lack of size can be more than compensated by quantity, and insects are the most dominant of all the creatures upon the earth. Roughly speaking, scientists have described about three-quarters of a million different creatures upon the globe, and of these, 470,000 are insects, more than all the others, beasts, birds, fishes and all the rest, put together.

Fortunately, the insect hordes are not all arrayed against man, although the emphasis placed upon the harmful insect is apt to obscure the truth that insects are quite essential to the success of agriculture and horticulture. Do we realise, for example, that were insects to be wiped off the face of the earth, much of our crop of fruit would disappear also? Apple trees might blossom, but there would be no apples to gather in the autumn. One of the chief agents in fertilising the apple-blossom, manufacturing apples we might almost say, is the hive-bee; and in one of his books Mr. Harold Bastin tells of the failure of the orchards in a certain part of Huntingdonshire, except for one orchard, situated beside an apiary of fifty bee-hives, which had an abundant crop. The explanation was a simple one; the spring of that year had been cold, wet, and windy, and the bees from the apiary, unwilling or unable to take long flights in the unfavourable weather, concentrated on the apple trees nearest their homes, to the benefit of that very local apple crop.

The good work of the bees is no news to the orchard growers in England's fruit garden. During the prevalence of Isle of Wight disease amongst hive-bees a few years ago many districts lost almost their entire bee stock. As a consequence the threat to the apple crop became so serious that girls were employed to take the place of the departed bees, by climbing the apple trees and dusting the pollen from one flower upon the pistils of another with powder-puffs—one of the most sensible uses to which that cosmopolitan article has ever been put.

The farmer, equally with the horticulturist, shares in the benefits showered by the insects. His red clover, in the absence of certain of the longer-tongued humble-bees, would fail to set seed. It was so in New Zealand, as the early settlers discovered; for red clover never seeded there until, after many vain trials and the successful exportation at first of the wrong kind of humble-bee, the long-tongued forms were finally sent alive from this country, set free in New Zealand, and flourished. And now the once fruitless blossoms bear abundant seeds.

The fertilisation of flowers is but one of the insect's ways of helpfulness. Think of the multitudes of weeds which must be destroyed every year by the leaf-devouring larvæ of many butterflies, moths and beetles. It is only now that we are beginning to understand the significance of this anti-weed campaign on the insects' part. Until two years ago no one troubled his head about the fact that two kinds of chrysomelid beetles live entirely upon the leaves of the wild plant, St. John's wort, in this country. Yet this fact may be of vital interest to the stock-masters of Australia, for there, St. John's wort, imported by accident, has spread with such intensity that the pasture on half a million acres has been seriously damaged. And so our beetle allies have been called upon. Expeditionary forces of the two small beetles have been sent alive to Australia, where they have been bred with the care generally associated with pedigree herds, and where at the end of last year 3,000 were set free in five separate colonies to do their worst upon the alien weed.

If some insects are vegetarian, others are carnivorous, and these also perform prodigies of valour against the farmer's foes. The lady bird which devours green-flies to the tune of several thousands a day, the hover-fly larvæ which feast on the same foodstuff, the parasitic forms which destroy harmful insects, all contribute to place man in the insect's debt. A single example may suggest to what extent. Professor E. B. Poulton once collected 533 caterpillars of the large cabbage-white butterfly, and of these 422 never came to anything because they had been parasitised by an ichneumon fly, whose grubs lived upon the flesh of the caterpillars. A death-rate of over 79 per cent. means a considerable saving in the cabbage field.

The Pestilent Insect and the Secret of its Harmfulness.—Having put in a good word for the insect for the sake of fairness, we cannot but admit that there are many black sheep in the flock. Scarcely any crop escapes their attacks, and scarcely any stage of any crop but suffers in some way, from, to mention one example, the germinating grain in the field to the stored grain in the barn. Here again it is difficult to grasp the extent of the influence of insects, for they are insignificant creatures, and a grain here or a grain there does not seem to make much difference. Yet it costs the farmer a great deal in solid cash to run the insect pests of the country. I do not know that the losses have been investigated with care in this country; but in the United States of America a band of experts, each familiar with a particular type of crop, not long since pooled their information about the harmful insect. It came to this, that the percentage of loss in the various crops ranged from 3 to 10 per cent. of the yield, equal in a normal year to destruction amounting to the gigantic total of £453,000,000 sterling.

The secret of the harmfulness of the insect pest lies in mass attack, and mass attack can be carried out only because of the extraordinary fertility of insects and the power of many to produce rapidly succeeding generations. In his "Darwinism and Human Life" Sir J. Arthur Thomson gives a startling example of the gross result of a year's breeding in the case of the common house-fly. "The common house-fly lays eggs in batches of 120-150 at a time, and may lay five or six of these batches during its life—of about three weeks in very hot weather. At the end of the summer, if all developed, and if there were six generations, the progeny of a single pair, pressed together into a solid mass, would occupy a space of something like a quarter of a million cubic feet, allowing 200,000 flies to a cubic foot." There is the stuff that pests are made of. Fortunately they do not all develop, but the calculation suggests the threat that lies behind great fertility.

The Combating of Insect Pests.—But the calculation is of more practical value than that: it suggests also the one way in which pests may be fought, and that is by preventing their increase. This is not so easy as it sounds; but one thing is clear, that there can be no scientific grip upon the increase of pests until the natural causes which influence their numbers have been discovered.

Amazing fertility is the foundation of an insect plague, but were it the only factor we should be swamped by the myriads of house-flies. The gross numbers are interfered with by natural enemies, and by various extraneous conditions of the environment, such as warmth or cold, sunshine or rain; so that the gross numbers may bear little resemblance to the net result.

Of all the natural controlling factors none is more important than climate. No insect can escape the conditions of temperature and humidity; for although at first sight it seems that only such as are exposed to the direct action of the weather must suffer or benefit, second thoughts suggest that even in the soil or within the stem of a grass, a " leather-jacket " or frit fly, or whatever the pest may be, is in surroundings which themselves feel the effect of the weather.

It is clear, therefore, that if insect pests are to be rationally dealt with, a first study must be to determine the influence of climate upon the successful propagation and survival of insects.

For this reason we welcome the important paper on " Insects and Climate " which has just been published in the *Transactions of the Entomological Society of London* (vol. 79, part I, 1931) at the instance of the Dietetics Committee of the Committee of Civil Research. In this bulky memoir of 247 pages the author, Mr. P. B. Uvarov, has brought together for the first time practically all the published information dealing with climate or weather in its relation to insects. It is a valuable summary which will be the foundation of much future work, for as well as showing what has been done, it points a finger at the enormous blanks in our knowledge which still remain to be filled in.

It is impossible to discuss the mass of material in the paper, one of the main features of which is the detailed and thorough analysis and classification of climatic effects on insects at all stages of their chequered careers. But a few of the many striking facts of general interest may be alluded to.

Effect of Climate on Destruction of Insects.—An enquiry such as this is bound to investigate the extreme limits of temperature at which any insect can live, as well as the range through which it is most active and harmful; for while the latter may suggest the season of plague, the former may give a key to a method of control. The extraordinary degree of cold which some insects can withstand may come as a surprise to those of us who associate the hum of bees and the buzz of flies only with the blazing heat of summer. Yet some insects live upon the snow-fields; the winter-fly (*Chionea araneoides*) has been observed to be active on snow at an air temperature six degrees below zero (−6°C.), while in the arctic regions humble-bees visit flowers and are fully active at four degrees above freezing point.

Put upon their mettle, however, insects can do much better than this. So long ago as 1736 Réaumur discovered that caterpillars might be frozen hard and yet return to active life on the raising of the temperature; and the great arctic explorer Captain Ross, during his voyage in 1835 in search of the North-West Passage round the world, submitted caterpillars (of *Laria rossi*) to four successive exposures of frost, varying between −11·45° and −47°, and found that they afterwards produced one adult moth and several parasitic flies. Recent experiments show that young grasshoppers can withstand a temperature of

- 7°C. for at least 24 hours, and mosquitoes (*Anopheles maculipennis*) - 31° for 10 hours.

Some of our common insects seem not to be troubled by moderately low temperatures, for humble-bees will continue to gather honey in the midst of a snow or hail storm or in rain, long after other insects have rushed for shelter; and that makes humble-bees the most satisfactory of flower fertilisers. Others, like the clothes' moth, seem actually to thrive in coolness: several series of very careful experiments have shown that when caterpillars are fed at lower temperatures, the moths developed from them are larger and heavier than usual. The simple explanation seems to be that at low temperatures the caterpillar lives longer without changing into a moth, so that it eats more and waxes fat accordingly.

In spite of what has been said above, the farmer has much need to be thankful for the chills of winter. To that maligned season, more than to any other factor, is due the destruction which keeps in check the insect hordes. All insects are not equally susceptible to the rigours of winter, and study of the plagues of past years has shown that those which pass the cold season in the inactive, resting pupal stage come off best. Nor are all winters equally successful in controlling insects, as everyone knows.

Two sets of conditions influence the deadliness of winter. The first is the nature of the preceding autumn. A mild and wet autumn followed by sudden frosts is more deadly than a dry autumn with a gradual decrease in temperature. The second is the nature of the winter itself. Curiously enough it is not the steady, long-continued, hard winter which is most disastrous: the abundance of insects after exceptionally severe winters has often been noticed. But mild and unsettled conditions during winter play havoc, perhaps because some insects are induced to hatch during evanescent warm spells and others to migrate to the surface layers of the soil, in both cases to be cut off by the succeeding sudden frost.

Actual observation has shown how rudely winter may treat the insect. Even in an average season in the United States of America up to 70 per cent. of the eggs of the gipsy moth and 60 per cent. of the caterpillars of the European corn-borer have been found to be killed.

Weather-wisdom vindicated by Scientific Observation.—The scientific mind feels always so uncertain about the value of the simple omens of the countryside that it is refreshing to find one firm belief seemingly corroborated. Seamen and others have long believed that special activity in the insect world betokened the coming of wind or bad weather. In South America, for example, sailors regard the appearance of swarms of insects off the coast as an indication of the approach of the *pampero* or south-west wind. In Europe the appearance of a hawk-moth in calm weather several miles off the shores of the Caspian Sea is looked upon by the local fishermen as a forewarning of a coming north-east wind. Mr. Uvarov himself has had many opportunities of checking this belief, and always he found that the moths appeared some hours before the wind. So also during the great locust invasion of Egypt in 1915, on seventeen separate occasions the arrival of flying swarms of locusts in the Nile valley coincided with a low barometer, that is with the coming of unsettled weather. But the subject merits more detailed observations.

Moonlight and Love.—Just as individuals of the human race are said to be, by those who know, susceptible to the beams of the full moon, so some insects betray a like impressibility. Dr. Hora noticed in India that swarms of mayflies appeared and engaged in their courtship dances in the air about the period of the full moon. Struck by this strange fact he studied the dates of the swarming of mayflies in other countries, and discovered that in each species the appearance of the swarms coincided with a definite moon phase. But not all insects love the moon. It has been found that at the time of full moon few moths are caught at baits until the moon has set, and when in 1929 an American experimenter created an artificial moon by placing six 500-watt Mazda lamps above a block of 15 apple trees, so that the light beamed upon the trees at the time of the flight of the codling moth, he found that the moths were so disturbed that many refused to lay their eggs, and the fruit benefited accordingly.

The Forecasting of Insect Plagues.—To the casual reader some of the information gathered together in the learned paper I have been referring to may seem far removed from the practice of agriculture. But it may not be so : it is impossible to say what may turn out to be the causes contributing to any particular plague, and until all the manifold influences of climate in its widest sense have been probed, the scientist, and with him the farmer, must walk blindfold. Till now the scientific worker has done little more than record and describe insect plagues, and speculate as to their causes. But as knowledge increases, his hesitating forecasts, which have already been modestly successful, will gain in precision and practical value. The outlook for the future is promising, and the Economic Advisory Council and Mr. Uvarov are to be congratulated on the publication of a body of evidence which will be of prime importance in directing future investigations into the bearing of climate upon insect pests.

FAULTY DIET AS A FACTOR IN DISEASE.[1]

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It has always been commonly believed that the amount and kind of food eaten affect susceptibility to disease and the experience of the race fully justifies this belief, for pestilence has always followed on the heels of famine. In the folklore of dietary customs there are many illustrations of the belief that, not only the amount, but the kind of food is important for health. Various fruits and herbs have had for centuries the reputation of conferring upon the eater a degree of immunity against some disease or other.

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[1] This paper is the summary of a lecture delivered by Dr. Orr at a meeting of agricultural scientists at Guelph, Canada, in June 1931.

It is remarkable that in spite of this widely held belief, which was shared by many medical men, it is only within the last ten or fifteen years that systematic investigation on the subject has been undertaken. The delay in applying our modern wealth of biological knowledge to this subject is due to the fact that the attention of the medical profession has been directed too exclusively to the micro-organisms which cause disease. The discovery of the existence of these organisms and of the connection between some of them and the infectious diseases which they cause has enabled us to reduce to vanishing point some of the great epidemic diseases which, in former times, swept across countries, decimating the population. It is not to be wondered at, therefore, that for more than half a century after this great discovery the main weight of medical research should have been devoted to the exploitation of this new light on the cause of disease, to the neglect of the fact that the condition of the host may be a factor in determining whether or not these organisms gain entrance to the tissues and there produce the diseases of which they are the primary cause.

Recent advances in the science of nutrition are now leading us to pay more and more attention to the condition of the host as a factor in the causation of disease. Since the beginning of the present century it has been established that there are a number of disorders known as "deficiency diseases" which are caused not by the presence of either micro-organisms or any other toxic agent, but to the absence of some constituent in the food. These diseases can be produced or prevented at will in experimental animals by withholding certain nutrients from or including them in the ration. Much of this information is now being applied in practice to the great benefit of the race. Thus we are able to prevent or cure certain diseases such as scurvy, beri-beri, rickets and pellagra which have caused a great amount of human suffering. Success is also attending the application of this knowledge by the reduction of disease among domestic animals. Rickets, osteoporosis, styfsiekte, goitre and anæmia, which in the past have been accountable for heavy losses, are now being prevented by proper feeding.

The discovery of these deficiency diseases, due to the absence of certain nutrients, in most cases either vitamins or minerals, marked an important advance in our knowledge of the cause of disease and our power to combat it. The practical importance, however, is greater than the mere prevention of these specific deficiency diseases. It has been noted that, according to the extent of the deficiency, there may be all stages of malnutrition from normal health to the gross signs of disease as seen in the moribund animal. The manifestations of the minor degrees of deficiency which are common to most of these diseases are decreased appetite, lowered vitality, lethargy, dull coat, lowered capacity for work or production, and, in young animals, sub-normal rate of growth. Now a point of great practical importance is that when under ordinary conditions these diseases appear, though only a few animals may show gross signs of disease, nearly the whole of the animals under the same dietary conditions show minor symptoms of deficiency. Young animals are incapable of making the maximum rate of growth. Full grown animals are incapable of producing to the full extent of their capacity, and none of the animals are capable of making full utilisation of the feed. This can be well exemplified from the data of feeding experiments. Thus, for example, in the case of pigs, the ration can be so adjusted that the rate of growth is only a half or a quarter of that obtained in comparable pigs on a complete ration; whereas the amount of food consumed per pound of gain may be two or three times that in the case of the animals on a complete well-balanced diet and therefore in perfect health. The great loss in farming is not the relatively small number of animals which die from rickets, goitre, primary anæmia or styfsiekte, but the large number of animals which are not in perfect health, and therefore not completely efficient as transformers of their feed into the desired animal product.

There is another aspect of the subject which may turn out to be of even greater importance for the welfare of the human race and the efficiency of stock farming. It is beginning to be realised that animals suffering from any degree of malnutrition due to an inadequate diet may be more susceptible to some infectious diseases than animals in perfect health. Let us consider some of the grounds for this belief. In the study of rickets it has been found that the composition of the blood of a rachitic animal is abnormal. The level either of serum calcium or inorganic phosphorus, or of both, is too low. It is most probable that these gross changes in composition may be associated with other changes which are too subtle to be determined by chemical analysis. Hence the deficiency in the diet that causes rickets, causes also changes in the circulating fluids of the body. As a matter of fact the primary change is in the circulating fluid. The bony deformities are the later results and outward clinical signs of this change. There is reason to suspect that, if the nature of the diet can make the blood so abnormal that a gross condition like rickets is produced, the abnormal condition may also affect the working of some of the defence mechanisms which protect the body against bacterial or protozoan infections.

Deficiencies in the diet may also lead to a disturbance of the normal healthy functioning of the organs. In some recent work it has been shown that in animals on an inadequate diet the rhythmic peristalsis of the intestine is disturbed, leading sometimes to excessive movements, but more frequently to delay in emptying the bowel. In tetany, which is dietary in origin, there is a marked disturbance of the nervous system. It is most probable that these disturbances of the functioning of the alimentary or nervous system are accompanied by derangement of function of other organs.

There is evidence that in malnutrition due to faulty diet the entrance to the body of pathogenic organisms may be facilitated. In most cases of infection, invasion takes place by the mucous membranes of the intestinal or respiratory tracts. Histological examination of the tissues of animals suffering from deficiency disease has shown that these mucous membranes are frequently in a pathological condition in which the normal resistance to invasion is weakened.

We have seen that deficiencies in the diet may lead to abnormalities in the composition of the blood and derangement of function of organs which are likely to embarrass the defence mechanisms of the body, and in addition to lower the vitality of the mucous membranes where invasion by pathogenic organisms takes place.

These results of recent biochemical and histological work on deficiency diseases would lead us to expect that under those conditions resistance to some diseases at least would be reduced. Observations made on groups of experimental animals lend support to this supposition. It has been repeatedly noted that the death-rate due to infections of the respiratory or alimentary tracts is higher in groups of experimental animals fed on deficient diets than in comparable animals fed on complete diets. Classical examples of the association of deficiency in the diet with increased susceptibility to disease are the development of xerophthalmia in rats and of epithelioma contagiosum in fowls. Both these diseases are due to micro-organisms, and are liable to develop in animals on deficient diets. But their development can be prevented by the addition of cod liver oil to the diet, even though the animals are in the same environment and subject to the same infections.

The results of these recent investigations warrant us in accepting the view that in animals fed on inadequate diets the invasion of pathogenic organisms is favoured, and the organisms, having gained entrance, find in the abnormal tissues and fluids of the body an enfeebled resistance to their multiplication and to the production of their toxic products which give rise to the specific signs of infection. This view is being accepted as a working hypothesis at several centres of research where the subject is being intensively investigated. On account of the complexity of the problems, these investigations are beset with difficulties and the advance in knowledge is likely to be slow. There is great need for more work of the kind to which we have referred, for it is this fundamental research on the biochemical, histological and immunological abnormalities due to faulty diet which alone can yield the information we urgently need in this new aspect of the fight against disease.

So far we have referred only to the results of investigations on experimental animals. The question of practical importance is, to what extent do these deficiencies in the diet occur under ordinary conditions among mankind and animals, and if they do occur, to what extent can they be correlated with sickness and death-rate? A few years ago some investigations on both human beings and animals under ordinary conditions were undertaken from the Rowett Institute to throw light on these points. An enquiry was made on the nature of the diet and of the incidence of disease in two African tribes with different dietary habits. The diet of one of the tribes consisted mainly of cereals. The calcium content was low, and this was most probably associated with deficiency of vitamin A, though the vitamin content of the diet could not be determined. The diet of the other tribe consisted mainly of milk, raw blood and meat. It was very rich in both calcium and vitamin A, which were deficient in the diet of the former tribe, though of course it was defective in other respects.

A survey of the incidence of disease in the native reserves showed that in the tribe on the cereal diet pulmonary conditions, especially bronchitis and pneumonia, accounted for 31 per cent. of all cases of sickness: tropical ulcers for 33 per cent. and pulmonary tuberculosis for 6 per cent. In the meat-eating tribe with a high calcium and high vitamin A intake, the corresponding figures were 4, 3 and 1. On the other hand, this tribe suffered extensively from rheumatoid arthritis and intestinal statis, which were the most prevalent diseases. This survey is not regarded as more than a preliminary enquiry. The results, however, are so striking that they seem to warrant the belief that there are native tribes in Africa whose customary diet is deficient in certain nutrients and that these deficiencies lower resistance to some diseases, the primary cause of which is invasion of the body by pathogenic organisms.

There has just appeared an account of another investigation carried out with the same object, but on different lines to the enquiry on the African tribes. At the Pasteur Institute in Southern India groups of rats were fed on diets resembling those eaten by different peoples in India. One group received a diet similar to that eaten by certain peoples in Northern India "among whom some of the finest physical specimens of mankind are to be found." The diet consisted of whole meal flour, unleavened bread, butter, a legume, carrots and cabbage, milk and raw meat with bones. So far as our knowledge goes this should supply a complete and adequate diet. For the two and a quarter years during which they have been under observation these animals kept remarkably free from disease. Other groups were fed on faulty diets, the materials for the diet being those in use by the people of the plains of India; sometimes actual Indian dietaries were used. These were ill-balanced diets, composed mainly of cereal grains or cereal products, with very little milk, butter or fresh vegetables. In this group there was a high incidence of disease. Many of the diseases noted, such as infections of the respiratory and gastro-intestinal tracts, are similar to those found in human beings.

These two investigations carried out quite independently and on different lines point to the same conclusion, viz.: that in native races where there is a high incidence of disease deficiencies in the diet may be an important, and probably the most important, etiological factor.

This condition of affairs may exist in many native races with a low standard of living, but is there any evidence to show that the dietaries of civilised countries are so inadequate that the resistance to disease of the individual is sub-normal? An enquiry to obtain some information on this point was carried out a few years ago by the Rowett Institute. A dietary survey was made of 600 working class families in the seven largest Scottish towns. The enquiry was concerned mainly with the question as to whether or not the diets were sufficient to support maximum growth and maintain perfect health in children. It was found that, though the energy value of the diet was abnormally low in only two cases, there was in the greater proportion of the dietaries evidence of deficiency of some of those nutrients the absence of which causes deficiency diseases. The intake of either calcium or phosphorus or both was too low in about 25 per cent. of the cases. The intake of iron was too low in over 50 per cent. of the cases, and the intake of the protein, though sufficient for adults, was below the optimum requirements for children in about 40 per cent. of the families. Unfortunately, it was impossible to determine exactly the vitamin intake, but it is most probable that there was also deficiency of some of these.

We must not place too much importance on these findings, because too little work has been done to enable us to know with certainty the requirements of the child for some of these constituents. It is possible that the standard of requirement which we assume from the limited data available is too high. The results, however, appear to be of significance when considered in the light of another test which was done on children in the same districts. In that test it was found that the addition of milk, either whole or separated, during a seven months' experimental period was accompanied by a rate of growth about 20 per cent. greater than that in children not receiving the extra milk. The clinical examination of the children showed that the increased rate of growth was accompanied by an improvement of the general condition. It should be noted that the additional milk would completely make good all the deficiencies with the exception of iron. If the results of these investigations on Scottish school children can be accepted as reliable, they indicate that even in our highly civilised communities the diet of a large section of the population is inadequate for the rearing of perfectly healthy children with a high resistance to disease.

Concurrently with these studies of the subject in human populations, observations have been made on sheep kept under natural conditions. A few years ago an enquiry was undertaken to ascertain whether there was any dietary factor involved in the high death-rate in sheep in the Western Highlands of Scotland. As pasture is the chief and in many cases the sole food, an exhaustive investigation was made on the chemical composition of the pastures in those areas as compared with that of pastures in areas where disease was much less prevalent. It was found that in the areas with the high incidence of disease the pastures were relatively poor in certain mineral ingredients and to a lesser extent in proteins. It was thought that they might also be poor in some of the vitamins. Tests were carried out on various hill farms to ascertain whether the feeding of substances thought to be deficient in the pastures would be followed by improved nutrition and decreased mortality. These tests were so complicated by the handling of the sheep for commercial purposes that it was difficult to get reliable data. The general results, however, seemed to indicate that in areas where mortality was high, improved nutrition accompanied by a decrease in mortality followed the supplementary feeding.

The results were sufficiently promising to warrant making provision for work under more exact conditions, and a sheep farm was taken over along with the existing stock, so that the workers might have complete and continuous control of the animals. It should be noted that the animals under observation on this farm were not put upon special diets, nor confined under artificial conditions. They were allowed to remain grazing on the hill, their diet, with the exception of the additions made to the experimental groups, consisting of the natural grazing.

Observations were made throughout a full year on the clinical state of the animals, especially changes in body weight, birth-rate and death-rate, on the chemical composition of the blood and on immunological reactions of the blood. It was found that under these natural conditions the animals lost weight during the winter and early spring, the loss in animals under a year old, which were still growing, being as much as 30 per cent., whereas similar animals kept on good pasture made slight gains. Chemical examination of the blood showed that there were changes in both serum calcium and inorganic phosphorus. In the case of the calcium the fall reached as low as only 70 per cent. of the normal in the early spring. Accompanying these changes in the clinical condition of the sheep and the chemical composition of the blood, there were changes in the immunological reactions of the blood serum.

In the following year some extra food in the form of maize was given to one group of animals, and calcium salts and cod liver oil to another group. The addition of the maize reduced the loss in weight, and the addition of the calcium salts and cod liver oil reduced the fall in serum calcium. In both cases there was an increase of over 10 per cent. in the birth-rate and a decrease of 40 per cent in the death-rate as compared with the control group, which received nothing in addition to their grazing.

As the effects of these additions have only been observed for one year, it would be very unwise to place too much importance on the birth-rate or death-rate figures. If these indicate a true result there should be a cumulative effect which will be more evident in the second and third generations.

At the Onderstepoort Veterinary Research Station in South Africa observations of a somewhat similar kind have been made in cattle grazing on pastures markedly deficient in phosphorus. It has been found there that the inorganic phosphorus of the blood of these animals is abnormally low and the level can be raised by the feeding of any phosphorus-rich foodstuff, and that the rise in blood phosphorus is accompanied by an improvement in the condition of the animals.

It should be clearly understood that in the case of the sheep in Scotland in calcium deficient areas, and the cattle in South Africa in phosphorus deficient areas, there is known to be a marked deficiency of one at least of the essential nutrients. They are, therefore, extreme cases. While observations on them throw light on the general problem of nutrition in relation to disease, they give little information with regard to stock farming under more intensive conditions where the diet is more varied. Among these animals there is, of course, a very high sickness rate. Indeed, losses from sickness and disease is the biggest difficulty which the stock farmer has to contend with. But to what extent malnutrition due to deficiencies in the food increases the susceptibility of these animals to some of the prevalent diseases is quite unknown. The problem is obviously one of great economic importance. Indeed, it is undoubtedly the field of nutrition that is of greatest practical importance at the present time.

In conclusion it should be emphasised that although some of this very recent research in nutrition seems to indicate that the nature of the diet is an important factor in determining the susceptibility of men and animals to some infectious diseases, we must guard against over-emphasising the importance of this and consequently under-estimating other aspects of the fight against disease. Nothing learned in the last ten years contra-indicates the extensive measures being taken in both human and veterinary medicine in the direct attack upon pathogenic organisms which are primary causes of infectious diseases. These measures have been highly successful. If, in addition to these, we can take measures to increase the resistance of the individual to infection, there are grounds for belief that in the future we may see a still further reduction in the amount of disease amongst men and domestic animals.

Note.—The following publications give more detailed information on the experimental work referred to in the above address :—

(1) M'Carrison : " Studies in Deficiency Diseases." *Oxford Medical Publications*, 1921.

(2) Orr and Leitch : Iodine in Nutrition. *Med. Res. Council Pub.* No. 123, 1929.

(3) Orr: Development of Science of Nutrition in Relation to Disease. *Brit. Med. J.*, May 23rd, 1931, 883-886.

(4) Magee, Anderson and M'Callum: Some Remote Effects of Deficient Diets on the Rhythmical Movements of the Isolated Intestine. *Quart. J. Expt. Physiol.*, 1929, 19, 171-179.

(5) Orr and Gilks: Studies of Nutrition. The Physique and Health of Two African Tribes. *Med. Res. Council Pub.* No. 155, 1931.

(6) M'Carrison: Some Surgical Aspects of Faulty Nutrition. *Brit Med. J.*, 1931, No. 3674, 966-971.

(7) Orr and Clark: A Dietary Survey of Six Hundred and Seven Families in Seven Cities and Towns in Scotland. *Lancet*, 1930, 219, 594-599.

(8) Orr and Clark: A Report on Seasonal Variation in the Growth of School Children. *Lancet*, 1930, 219, 365-367.

(9) Orr, Macleod and Mackie: Studies on Nutrition in Relation to Immunity. *Lancet*, 1931, 220, 1177-1182.

TRANSIT FEVER.

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This article is an abstract from a Report submitted by the writer to the Science Committee of the Animal Diseases Research Association. The remit from the Science Committee to the writer was to "study the conditions of transport and the marketing of Irish Store Cattle and their relation to the occurrence of Transit Fever."

The cost of the enquiry was defrayed by a Grant from the Development Commission.

"Transit Fever" has been the cause of considerable loss of stock for many years. It is not a new trouble and there is no information regarding the extent of its increase or decrease; nevertheless, from statements made in Aberdeenshire it would appear that since improvements have been effected in the Orkney cattle trade there is now less disease among Orkney cattle than was formerly the case. In this enquiry the Orkney cattle traffic was not investigated.

The term "Transit Fever" is given to illness that occurs among cattle a short time after their arrival at a farm. It seems to be most commonly met with among young store cattle that have recently been transported from Ireland or the Orkney Islands. Older cattle and cows are also affected. The noteworthy feature is that if the cattle arrive at a farm within two or three days after landing at a port, the disease becomes manifest in from six to ten days after arrival. If, on the other hand, affected cattle are not sold at the first market at which they are offered and are held over for the following week, they become obviously ill either at the market or within a day or two after arrival at the farm. This appears to be a characteristic and important feature of the disease. It is to be noted that the same incubative period applies to cattle in England, where the disease is not referred to as "Transit Fever." In certain quarters the opinion is held that transit fever is a disease peculiar to Scotland and Northern England. There is no evidence that this opinion is correct; on the contrary, it is known that cattle do become affected with a similar disease at the same period of time after arrival at the farm as prevails with transit fever in Scotland.

It must be clearly appreciated that the cattle, whatever their destination, are all in more or less close contact at the Irish ports; that the ships, whether sailing to Scotland or to England, are of the same type, and ventilated in a similar manner; and that the voyage to English ports takes more time than a voyage to Scotland. For example, the voyage from Belfast or Larne to Ayr occupies from five to seven hours; from Dublin to Glasgow, fourteen hours; and from Cork to Birkenhead, twenty hours. In the course of this enquiry one lot of affected cattle was traced back to the port of Ayr. One would think that if sea transport were the primary cause of the disease, there would be more disease in England than in Scotland, but this is not the case.

There has been a general impression in Aberdeenshire—where the disease has been very serious—that it was caused by close confinement in badly ventilated byres, and it is stated that the disease has decreased since the practice of keeping these young store cattle in the open air has become more general. While not disputing that close confinement may be a contributory factor, there is evidence that the disease may occur when the cattle are not housed at all after purchase. For example, during the course of this enquiry eight young store cattle were found to be ill in Berwick market. These formed part of a lot that had previously been offered for sale in Edinburgh. Another lot of cattle which was landed at Ayr on February the 12th, 1929, was offered for sale at Edinburgh on the 13th, and being unsold lay for seven days and was sold at the next market on the 20th. Two of these cattle died two days after arrival at the farm. The disease had also been noted in a field among cattle that had been bought eight days previously, and which had not been housed at all after leaving Merklands wharf.

It is possible to quote other instances of a like nature, but these will be sufficient to show—(*a*) that the disease appears from six to ten days after landing, and (*b*) that bad housing conditions on the farm are not the primary cause of the disease.

During the course of this enquiry, farms were visited in various parts of Scotland where there were outbreaks of transit fever, and the following ports were visited:—Dublin, Belfast, Londonderry, Larne, Ayr, Greenock, Merklands and Birkenhead. At the Irish ports cattle were closely inspected and the loading of a large number of ships was witnessed, many of the ships being boarded during the loading and, in order to get an impression of the conditions prevailing on board at the end of the voyage, many ships were met on their arrival at Merklands and Birkenhead and were boarded before disembarkation began. Cattle trains arriving at the ports in Ireland were also met, and the condition of the cattle noted as they left the trains for the wharves.

An idea of the extent of the trade in the export of cattle from Ireland may be gained by studying the Official Returns for the year 1929 which are reproduced in Table I. From this it will be seen that the total number of cattle of all kinds exported from the Irish Free State and the Northern Ireland ports was close upon 900,000.

TABLE I.

DEPARTMENT OF INDUSTRY AND COMMERCE (Statistics Branch).

Return showing by Ports of Embarkation the Numbers of Animals exported from Ireland to Great Britain and the Isle of Man during the year ended 31st *December* 1929.

	Cattle.					
	Fat.	Stores.[1]	Milch Cows.	Springers.	Calves.	Total.
IRISH FREE STATE PORTS :—						
Ballina	662	113	4	6	5	790
Cork	11,485	51,024	1,421	7,256	23,336	94,522
Drogheda	23,913	10	1	3	3	23,930
Dublin	224,240	132,641	33,917	1,514	7,146	399,458
Dundalk	10,038	515	7	...	...	10,560
Galway	15	348	..	...	...	363
Greenore	2,502	32,194	1,670	1,195	...	37,561
Limerick	1,737	5,642	...	...	...	7,379
Rosclare	...	...	...	...	..	...
Sligo	1,241	1,193	3	5	263	2,705
Waterford	29,986	36,798	271	1,851	11,812	80,718
Westport	271	...	...	...	...	271
Wexford	2,122	...	...	...	...	2,122
Total	308,212	260,478	37,294	11,830	42,565	660,370
Total for previous year	287,124	265,362	35,954	9,139	37,190	634,769
NORTHERN IRELAND PORTS :—						
Belfast	21,014	63,252	15,958	3,213	25	103,462
Larne	61	32,704	13	407	1,551	34,736
Londonderry	10,751	58,039	900	1,403	13,533	84,626
Newry	36	173	30	12	...	251
Total	31,862	154,168	16,901	5.035	15,109	223,075
Total for previous year	33,683	154,663	14,793	5,438	12,038	220,665
ALL IRISH PORTS	340,074	414,646	54,195	16,865	57,674	883,454
Total for previous year	320,807	420,025	50,747	14,577	49,278	855,434

[1] Including heifers for breeding and bulls for breeding. The figures for ports in Northern Ireland have kindly been furnished by the Ministry of Agriculture, Northern Ireland.

Conditions under which Irish Store Cattle are Marketed and Transported.—It is well known that many of the cattle intended for shipment at the Irish ports arrive there from landward areas in a tired condition. This is shown by the Official

Returns of the Port Veterinary Inspectors showing the number of animals held back as being unfit for shipment. (See Table II.)

In general, the collection and transit of the cattle (the young store cattle are designated " Calves " in official returns) in Ireland is by one of two methods. (*a*) They may leave a farm in the early morning for a fair, walking sometimes many miles by road; from thence they are sent to the port by an ordinary goods train or by a " special." (*b*) They may be purchased at the farms and collected for rail without the intervening exposure at a fair. It appears that the use of " special " trains is becoming more common than formerly. Needless to say the cattle suffer less from exposure if they do not pass through a fair, and also if they are despatched by " special " trains instead of by ordinary goods trains. The train journey itself may be a very lengthy one—from five to twelve, or even fifteen hours—and to this must be added an additional six to ten hours occupied by walking to and standing in the fairs. It is to be expected therefore that some of the cattle will arrive at the ports suffering in more or less degree from physical and nervous exhaustion, and evidence that such is the case is supplied in the Official Portal Inspection Returns given in Table II.

TABLE II.

Unfit for Shipment for Year 1929.

Port.	Lame.	Age and debility.	Indurated udder.	Blind.	Injured.	Near calving.	Sheep scab.	Other causes.
Ballina ...	12	15	11	2	2	...	...	5
Cork	277	148	212	3	6	129	...	66
Drogheda ...	84	8	56	...	...	...	40	21
Dublin ...	2,731	692	2,505	...	41	...	547	188
Dundalk ...	91	2	8	...	...	...	271	6
Galway ...	2	4	...	...	...	...	...	17
Greenore ...	246	2	8	1	3	...	50	16
Limerick ...	15	46	29	..	...	...	...	...
Sligo	1	...	47	...	...	...	56	
Waterford...	60	...	17	...	...	...	...	22
Westport ...	...	21	...	...	...	...	...	6
Wexford ...	...	...	1	..	...	...	...	...
	3,519	938	2,894	6	52	129	964	347

It will be seen that during 1929, 3,519 animals were stopped for lameness and 938 for age and debility, a total of 4,457 for these causes for all ports in the Irish Free State. Dublin alone stopped for lameness, age and debility 3,423.

After arriving at the ports in Ireland, the cattle are detained at the lairages for a minimum period of two hours for veterinary inspection. They are watered and liberally fed with good hay. The veterinary inspection is carefully done, but under what can only be described as somewhat difficult conditions. The lairs are for the most part uncovered, and the cattle after coming off the train have to stand in the open, fully exposed to the cold winds and wet of the winter.

There appears to be a certain lack of authority on the part of the veterinary officials to exclude from the lairages men connected with the trade. Owners, agents and drovers seem to be constantly among the cattle, drawing and marking, and generally moving them about. Boys off the street dodge about with cans and milk the cows whenever an opportunity occurs.

In general the conditions prevailing at Dublin, Belfast and Londonderry did not leave a very favourable impression. At Larne the cattle are run direct to the detention lairs at the wharves, and are handled and shipped by railway officials.

It would seem to be advisable that for a period of at least two hours before shipment begins, and from the time watering and feeding have been carried out, no persons other than the veterinary officials and persons authorised by them should be admitted into the lairs.

So far as young store cattle (calves) are concerned the provision of pens so covered as to exclude rain and snow and to give protection against cold winds would appear to be worthy of consideration, and it is possible to give these young animals protection against inclement weather without confining them in badly ventilated closed-in buildings. At the time Londonderry was visited new covered-over pens were in the process of erection and have since been completed.

Embarkation.—This is carried out under the supervision of the veterinary staff and ship inspectors. A certain amount of adverse criticism having been made on the manner in which the cattle are loaded in Ireland, one was relieved to find—after having witnessed the loading of a large number of boats, and having boarded many of them during and after loading—that the accusation of hurrying and bad usage was grossly exaggerated. It should be noted that under the Transit of Animals Order no sticks are allowed to be used, an approved goad being the only " stick " permitted to be in the hands of the drovers. It is true that now and again there was some evidence of hurrying, and a certain amount of unnecessary shouting, but the writer saw nothing to which real exception could be taken. It is natural for cattle when they enter a gangway to crowd on to those in advance, and from time to time this must necessarily be checked, but although the loading was watched time and again at different ports there was no evidence of this being done other than in a sensible manner.

The Ships.—The carriage of live stock by sea is controlled by the Transit of Animals Order, and is carefully supervised by the officials of the Ministry of Agriculture and Fisheries and of the Irish Free State.

In view of the fact that there are over sixty ships engaged in carrying cattle from Ireland to England and Scotland, it was obviously impossible to inspect more than a small percentage of the whole. Five voyages were made from Ireland with cattle, and many ships were boarded at the Irish and Scottish ports and at Birkenhead for the purpose of seeing how the loading was done and of inspecting the condition of the cattle on their arrival at the port of disembarkation.

The size of the pens was found to be in accordance with the requirements of the Order, and while it is true that all the suitable and available space for the carrying of cattle is utilised, in not one instance was overcrowding, either in any part of a ship or in any individual pen, noticed. In view of the fact that statements have been made to the effect that cattle are forced into the pens and packed tight, it seems to be necessary to point out, as is well known to people experienced in handling live stock, that, within reason, a full pen of cattle is carried with greater safety than one that is half full. A great many pens were examined and hundreds of cattle were handled, but an overcrowded lot was not once detected. In one instance, however (but only in one), a store beast was found placed among much larger cattle, which prevented the young animal from getting its head up and breathing fresh air.

Cattlemen are carried on the ships and are among the beasts throughout the voyage. Thermometers are hung in various suitable places, and the temperature has to be recorded by the chief officer and forwarded to the owners of the ship at the end of each voyage.

In addition to the natural ventilation by shafts and cowls, the ships are fitted with electrically driven fans, both intake and discharge, which are essential for satisfactory ventilation of the between decks. The fans are started before shipment of the cattle begins.

Particular attention was paid to the condition of the atmosphere on these ships during the voyages that were made, and without exception the ventilation was found to be quite satisfactory in every way, and it was evident that if the mechanical ventilation of these ships is properly attended to it can be described as thoroughly efficient. That the system is liable to break down, however, was shown by the condition of one ship on her arrival at Merklands wharf. On several occasions the ships were met early on Sunday morning as they arrived at Merklands, and were boarded before disembarkation began. On March the 30th, 1930, four ships arrived at the wharf with 329, 172, 176 and 396 cattle on board respectively. All the beasts appeared to be in good condition with the exception of those from the ship carrying the 329 cattle. Accompanied by one of the Ministry's officials, the writer boarded this ship as she came alongside the wharf at 10 a.m. The conditions in the aft between decks were bad. All the metal work was dripping with condensation water; the backs of all the cattle were wet; the atmosphere was foul, and there was strong concentration of ammonia—to such an extent as to make the eyes smart. This part of the ship is fitted with two powerful fans—an intake at the aft end and a discharge at the forward end, and it is important to note that for the satisfactory working of this mechanical ventilation the iron door opening to the head of the ramp leading down to the between decks must be kept tightly closed; if left open by carelessness the whole system breaks down.

It will easily be realised that if cattle are carried under such conditions as were found on this ship, and then landed at the wharves during the cold winter months, they would be very severely chilled.

The owners of the ship, having heard that she had been found in an unsatisfactory condition on arrival at Merklands, suggested that a special voyage should be made on her. Accordingly a few weeks later the writer, accompanied by the Ministry's Senior Veterinary Officer at Merklands, sailed on this ship for Londonderry, where on the following day 182 cattle, 8 sheep and 5 pigs were taken on board. The shipping company, in order to give every assistance in this enquiry, kindly filled the between decks with 130 store cattle, this being practically her full complement in that part of the ship. It is to be noted that on this voyage the weather conditions were adverse to the cattle (and to the reputation of the ship). It was raining during the loading and the cattle were thus shipped wet. There was a light following wind throughout the voyage—the worst condition for satisfactory ventilation. The cattle were taken on board at 6.45 p.m., both fans fully working before loading commenced. It was noted that as the between decks became filled with cattle the atmosphere became saturated with moisture, but the fans were so efficient that by 8 p.m. all trace of " steam " had gone. There were two thermometers in this part of the ship, one placed at each end of the compartment, and the following personal records were made of the temperature :—

	Aft End.	*Forward End.*
7 p.m.	62° F.	66° F.
8 p.m.	62° F.	66° F.
10.15 p.m.	62° F.	65° F.
4.45 a.m.	59° F.	62° F.

On the following morning at 5.30 a.m. 97 cattle were landed at Greenock, and the remainder at Merklands at 8 a.m. Notwithstanding the adverse conditions of the weather (absence of wind and the wet state of the cattle when shipped) no fault could be found with the ship, with the possible exception of a small dead pocket at the forward end of the aft between decks on the starboard side, measuring about 12 feet by 10 feet. All the cattle were landed in very good condition.

Especial reference has been made to the experience on this ship because of the unsatisfactory state in which she was found at an earlier date. This trip, which was made under adverse conditions, provided convincing proof that both the ship and her ventilating equipment were satisfactory, provided of course that the mechanical ventilation is properly attended to. There are two possible explanations for the foul condition of the air which was found on the former date—(*a*) that the fans were not kept working at full force, or (*b*) that the doorway at the head of the ramp was not kept closed. The obvious deduction from the experience gained in connection with this ship is that frequent voyages should be made on these cattle ships by the Ministry's officials.

In view of the statement sometimes made that "Transit Fever" is a condition unknown in England, it seemed to be advisable to visit an English port for the purpose of making first-hand enquiries, and the port of Birkenhead was chosen. Through the courtesy of Mr. Slinn, the Ministry's official in charge, a visit was paid to the lairage at 9 a.m. on Saturday the 26th April, and a second visit the following morning at 8 a.m. for the purpose of meeting the ships as they arrived from Dublin, Waterford and Cork respectively. The vessel that arrived from Cork was boarded (with the Ministry's official) as she came alongside the wharf, the discharge of cattle being held up until all the pens had been examined. There were 394 head of cattle on board, and some of them were young stores of the same type which become affected with disease in Scotland.

The cattle were loaded at Cork at 11 a.m. on the 26th of April. The ship left Cork at 2.10 p.m. and arrived at the wharf at Birkenhead at 8.45 a.m., and went alongside to begin to unload at 9.45 a.m. on the 27th. Thus the voyage, from the time the cattle were boarded until the discharge began, lasted for twenty-three hours, a much longer period than is the case with the Scottish ports. Notwithstanding the fact that the ship had been lying off the wharf waiting for a berth for an hour (absence of movement of the ship causes a comparative air stagnation in the lower decks), the main deck alleyways and the between decks were quite cool and free from ammonia; the cattle were comfortable, and no fault could be found either with the fittings or ventilation.

Disembarkation.—The writer was much impressed by the quietness and efficiency with which the cattle were unloaded and handled. As is to be expected, the cattle come off the ships more quietly than they go on, the voyage having a depressing effect. No sticks are used during the unloading and movement of the cattle to the detention pens, and the work was invariably carried out quietly. Indeed the manner in which all the work of the detention lairages is carried out is worthy of high commendation. Under the Animals (Landing from Ireland, Channel Islands, and Isle of Man) Order of 1923, all cattle landed from Ireland have to be detained for the purpose of watering, feeding, rest and veterinary inspection for a period of not less than ten hours. This detention period is undoubtedly essential for the well-being of the animals. Extension of the time does not appear to be necessary, because the veterinary inspectors have the power, which they fully exercise, of detaining tired or debilitated animals.

The custom in most ports is that all the cattle of a type (for example, stores) are landed in a mixed lot, and are then " drawn " by the dealers' agents and penned accordingly. This work is done quietly and efficiently. Reference is made to this because one Irish dealer suggested that all the cattle should be penned on the ships as dealers' separate lots, and landed and penned separately. At the commencement of this enquiry the writer was somewhat impressed by the apparent commonsense of this suggestion, but later found that, while such a procedure might be possible at a small port like Ayr, it would not be feasible, even if possible, at a busy place like Merklands, where four or five ships may be arriving at the wharf in close succession. If the suggested procedure were to be adopted the ships would be delayed, and it is doubtful if in fact it would reduce the amount of handling of the cattle.

Food, Water and Bedding.—In all detention lairs there is a constant supply of fresh water, but as many of the cattle are very thirsty when landed, the custom is to allow them a moderate supply of water to begin with, and after they have been fed to turn the water on freely. (This custom is in agreement with the recommendation of the United States Authorities.) Hay is allowed in abundance and is of good quality, but on one occasion second-rate hay was found to have been issued.

The extent to which bedding is used, and the nature of the bedding supplied, seem to vary in different ports. If straw could be supplied for all the store cattle it would certainly make them more comfortable. Peat moss, which was found to be in use at one wharf, is unsuitable owing to its dusty nature.

Conveyance by Rail.—Conveyance by rail, particularly by an ordinary goods train, must add its quota to the general depression imposed upon these store cattle. During the winter months, when the disease is chiefly manifest, the journey from landward areas to ports in Ireland and from ports to markets in Scotland or England, is often cold and draughty, particularly with open-sided waggons. Though cattle-waggons are sometimes sheeted (with, one hears, doubtful benefit), it is a matter for consideration if cattle would not be made more comfortable, without being over-heated, if the lower parts of the waggons were to be closed up. (The lower parts of waggons cannot be closed for the carriage of sheep.)

It should perhaps be stated here that it has been suggested that transit fever is prevalent in Scotland because Scottish waggons are not properly disinfected. This statement is not true, and one must not lose sight of the fact that cattle waggons are moved to and from all parts of the country. The present method of cleansing and disinfecting waggons is very much more efficient than the old practice of whitewashing.

Local Markets.—Many of the markets in which the cattle are exposed for sale are cold and draughty, and it can be readily understood that exposure under such conditions is against the animals' welfare. One frequently sees cattle in a tired condition in markets. Store cattle get a great deal of handling when exposed for sale, and much of this appears to be unnecessary. There are some drovers who seem to think that they are not earning their money unless they are continually harassing the cattle. On one occasion the writer walked behind a dozen young stores which were being driven from the market to a nearby field; the drivers consisted of one drover and four small children, all armed with sticks, which were being applied to the backs of the cattle almost without intermission. It seems as if Local Authorities might pay more attention to this matter.

Summary.—As stated at the beginning of this communication, the purpose of the enquiry was not to investigate the nature of the disease or diseases designated "Transit Fever."

That transit fever causes serious losses to individual farmers and is a source of worry to those connected with the cattle trade, and the store cattle trade in particular, there can be no doubt, but what these losses amount to in any period is unknown. The trouble is chiefly seasonal—from October to the end of April, but it occasionally appears outside this period. The mortality is often very high. Whether the disease is simply a virulent form of pneumonia, malignant catarrhal fever, hæmorrhagic septicæmia or any other, all or none of these diseases, remains to be decided by a competent veterinary pathologist. In the writer's opinion the losses incurred warrant such an enquiry, and it would not appear to be an impossible undertaking for an investigation to be made in every instance where a beast becomes ill in the market or within a certain period after purchase. It has been suggested to the writer that for the purpose of gathering the necessary information regarding the extent and nature of this trouble, so far as Irish cattle are concerned, a condition under which movement licences are granted should be that the purchaser should report to an authority the occurrence of illness. Whether this suggestion is practicable or not is for those in authority to say; that there is need for enquiry there can be no doubt.

Conditions associated with the marketing and transport of young store cattle must have an exhausting and debilitating effect, and this, coupled with the close congregation of large numbers of animals, will predispose them to be receptive of pathogenic organisms.

So far as the actual transport by sea of Irish cattle is concerned, the conditions seem to be as good as it is practicable to make them, but it would appear to be advisable to ensure that before the cattle are embarked on the ships at the Irish ports they have a sufficient period of undisturbed and comfortable rest after the veterinary examination has been completed. It is suggested that the veterinary officials should be given control of the embarkation lairages, in order that during such period as may be decided upon as necessary no persons other than veterinary officials themselves, and those authorised by them, should be permitted to approach the cattle. This would not only

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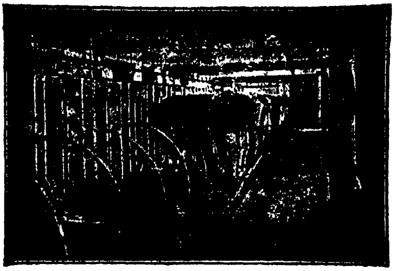

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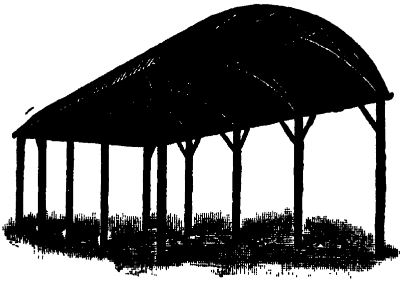

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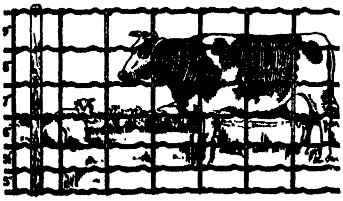

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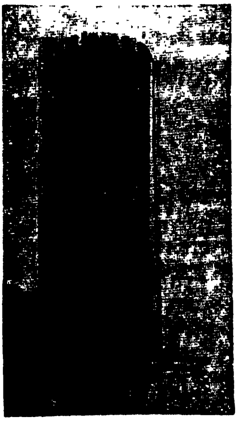

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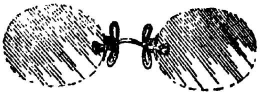

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be beneficial to the beasts, but would facilitate the veterinary inspection, which in addition to the prevention of the shipment of unfit animals, is for the purpose of detecting scheduled diseases, such as foot-and-mouth disease.

Hæmorrhagic septicæmia, also called " Shipping Fever," causes serious losses in the United States. The authorities there consider that this most commonly results from neglect or exposure of animals in transit or shortly after arrival at their destination. They stress the point that hard driving must be avoided and that ample time must be allowed for rest before loading.

In regard to the conduct of markets in Scotland, the existing laws, including the Protection of Animals Act (Scotland), 1912, give adequate protection to cattle against abusive or harsh treatment. It remains for Local Authorities to apply them.

This opportunity is taken of expressing appreciation of the marked courtesy and great assistance received during this investigation from the veterinary officials at the ports, and also from the officials of the Burns Laird Line.

THE BIOLOGIST on the FARM.—No. XLIII.

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The Vanishing European Bison.—We are glad to hear that the New York Zoological Society is sending Dr. W. Reid Blair, the Director of their Zoological Park, on a visit to Europe to see if anything can be done to save the European bison from extinction. It suffered terribly from slaughtering—partly coerced by hard times, but partly ruthless—towards the end of the Great War and afterwards. The great Caucasus herd disappeared altogether, in part before machine-guns, and the Lithuanian herd dwindled towards disappearance. According to the last Report of the International Society for the Preservation of the European Bison, there are only fifty-nine pure-blooded specimens left over the whole area, the largest herd being the Duke of Bedford's at Woburn Abbey. The Americans have been such successful custodians of the related American bison that they may be able to offer some useful advice to save the European species from utter destruction. It would be a tragic discredit to civilisation to allow this fine tenant of the primeval forests to disappear from the world-stage. But it is touch and go now. How slow man is to admit that he is only a trustee of the Animal Kingdom!

Wholesale Exterminations.—It is difficult to see one's way clearly in regard to the control of rapidly multiplying animals that are hostile to certain more than justifiable human interests, such as those of the farmer. Control is so apt to become tantamount to extermination, for which there is almost always a tax to pay. Even the total destruction of rats in a badly infested country like our own, a riddance for which there is much to be said, would almost certainly be followed by a huge increase of mice and voles unless the destruction of the rats is accompanied by a thriftier way of dealing with the " crumbs " and " surplusage " on which many rodents largely subsist. Here we have a general fact that may be stressed—that merely surgical or eliminative measures taken to remedy a disturbance of the Balance of Nature cannot have more than partial success if nothing is done to redress the unnatural conditions that brought about the over-abundance of the pests.

Thallium as Poison for Pests.—Another general principle is obvious to the biologically-minded, that the methods used to check the destructive pests should not be such that they destroy many other forms of life. Thus Dr. Jean M. Linsdale makes out a very strong case against the wholesale use of thallium in some parts of California as a poison for the troublesome ground-squirrels. In the year ending midsummer 1929 grain poisoned with thallium was scattered here and there over an area of five million acres. In 1928 there was a scattering of over two million pounds of poisoned grain; and no one doubts that many of the destructive rodents were eliminated. But Dr. J. Grinnell, one of the foremost naturalists in California, computes, in May of this year, that " in the last four years not less than fifty million animals other than ground-squirrels have been killed in California through these operations." These other animals include carnivores, game-birds and songsters; and the wastage is deplorable. It is not merely that the eliminative measures are taken on behalf of only a portion of the human population, for we must always be prepared for this sort of socialised give and take; the damaging fact is that the " innocent " are being destroyed with the " guilty " with inevitable damage to the whole fauna.

The Australian Flock Pigeon.—Everyone has heard of the somewhat puzzling rapid disappearance of the American Passenger Pigeon. It used to be seen in millions, but it dwindled rapidly during the second half of the nineteenth century, and then was suddenly lost for ever. The same sort of thing has been occurring in Australia, where the Flock Pigeons (*Histriophaps histriona*), which were seen as late as the end of last century in " countless myriads," in crowds two miles in length, have in most places become scarce. This rapid waning, in the course of a human generation, does not seem to be due to direct destruction by man nor to the spread of farming. It is probably due, though this requires further enquiry, to the increase of enemies, such as the stoats and other small carnivores, introduced by early settlers. For this particular kind of pigeon nests and feeds on the ground and is thus particularly liable to be attacked by the armies of aliens.

Experiments with Ringed Plovers.—In some parts of the country there are numerous nests of this dainty bird, and Mr. George Marples has utilised one of these haunts in some very interesting and wholesome experiments. He had more than forty nests under observation. Eggs removed for a short distance from the nest were retrieved, but the birds also brought in some painted oval pebbles and sat on them. But when the observer disguised the eggs with paint and plasticene the birds were not deceived. It has been recorded that this plover keeps its four eggs arranged north, south, east and west; and Mr. Marples has tested this. He disarranged 121 clutches, with the result that 80 were rearranged exactly north and south, 11 were nearly but not quite restored to the cardinal point position, while 30 remained in the disarranged position, north-east and north-west. As we are not all always busy, we venture to suggest that it would be an interesting pastime, and much more, to repeat the retrieving experiments on some other clutches, such as those of the lapwing.

Domesticated Reindeer in Canada.—One of man's lasting problems is to make the most of useful animals, and the importance of this increases as the world becomes more and more densely peopled. A recent attempt to make more of the reindeer or caribou in the great North Plains of Canada is full of interest practically and biologically. It has been vividly discussed by O. S. Finnie in the latest (July-August) number of *Natural History*, the very live journal of the American Museum in New York. The experiment is still in its early stages, and no one can predict the outcome; but the prospects are good.

The area concerned is an immense one—the northern part of Canada from Alaska to Hudson Bay, nearly two-fifths of the total area of the Dominion, and covering (including its non-tidal waters) about one and a half million square miles. The term Barren Grounds often applied to the Northern Plains is not a good one, since more than half a million square miles of sub-arctic forest are included.

When first explored these plains were teeming with caribou or Arctic Reindeer (*Rangifer arcticus*), just like the reindeer of North Europe and Asia. In days before firearms the caribou hunt used to be very laborious but the rifle has made it too easy, and the numbers have been greatly reduced. Apart from shooting there has been a heavy mortality due to a diverting of the old migratory routes, e.g. to the arctic islands before the fawning season, for this change has increased the exposure of the caribou to the attacks of carnivores and of injurious insects. Thus the Government, through the Department of the Interior, has of recent years been tackling the problem of conservation on the one hand and of domestication on the other, both in the hope of lessening the severity of the human struggle for existence. It must be understood that reindeer can thrive on lichens and dwarf vegetation in many a place where cattle would starve, and that the animal is in other ways admirably adapted to the conditions of the Far North.

Thus we may recall, just as an example, the spreading hoofs, with sharp cup-shaped edges, which give the deer a firm foothold on yielding hummocky ground in summer and on snow and ice in winter. In his *Wild Animals of North America* Mr. E. W. Nelson describes the extraordinary deposit of "back-fat"—a layer of pure tallow, which extends along the back from the shoulders to the rump, gradually thickening until it is four to six inches in depth. This slab of tallow serves as a store, which is burnt away in the hard winter, keeping up the supply of animal heat. It is much appreciated as food by the Eskimos and Indians, to whom the caribou means so much for sustenance and clothing, and also for transport.

For fifteen centuries or more there has been a semi-domestication of reindeer in the Arctic Regions of the Old World, and it was on these stocks that the Government drew in effecting introductions into Canada. Between 1892 and 1902, 1,580 reindeer were imported from Siberia and 144 from Lapland, and the result was a great success, all the more when some Laplanders accompanied their beasts to show the Eskimos of Alaska how to treat them. From the nucleus introduced into Alaska in the ten years referred to, there have arisen about 750,000 deer, besides the 200,000 or so killed for food and hides. Dr. Hornaday writes encouragingly:—"On the whole, the systematic introduction of reindeer along the north-west coast of Alaska—now almost barren of wild life fit for human food—is one of the most humane and sensible measures ever undertaken for the children of the cold. If this industry is further fostered and diligently pursued, its ultimate value in the promotion of the moral and material welfare of the Eskimo is beyond calculation. The multiplication of the herds in the hands of private owners means a great increase in the animal food supply, less dependence upon the foods of civilisation, a greater measure of general prosperity and contentment, and in the end far less expense to the Government in the form of annual maintenance for starving natives."

Now the point is that this experiment has been continued with very encouraging results, and we must all have read how Dr. Grenfell has succeeded in extending it to Labrador. What is now being tried in Canada is the transference of large numbers of caribou from Alaska to the North-West Territories, to areas where the pasture conditions are promising. The driving of thousands of deer from Alaska towards the Mackenzie delta has proved a very difficult task, owing to the breaking away of parts of the herd in obedience to their homing instinct, but it is being patiently effected. More patience will then be needed to train the young Eskimos to become herdsmen, not hunters. Mr. Finnie's conclusion is of great interest:—"It is still premature to foretell the possible outcome of the undertaking," but it is no fool's experiment. "It may be safely assumed that Arctic Canada has room for millions of domesticated reindeer in areas where, due to the severity of climate and inferiority of soil, other forms of agricultural development are at present out of the question, and where the country, aside from mineral possibilities and as a fur producer, would otherwise be unproductive." Of course the aspect of the problem that appeals to us at home is *not* the production of more food; but surely there are lessons, of plasticity and patience at least, to be learned from the great Canadian experiment.

Vanishing Treasures.—The Biologist seems to be obsessed in this number by the thought of man as a negligent trustee of the treasures of animal life, so it was a relief to record the modern story of the reindeer. But it must not be forgotten that the introduction of domesticated reindeer from the Old World was in part at least forced upon man because of the previous shortsighted thinning of the wild caribou. Nor can we forget that the interesting musk-ox, *Ovibos moschatus*, a unique ancient type, once very abundant, and with no natural enemies save wolves, is fast becoming a great rarity. For many years it has been unknown in Northern Alaska, and on the mainland of Canada it only survives in a few protected herds. It is a deplorable muddle that we are making of our trusteeship; and biologists are by no means free from blame. There is lurking in us a predatory urge to secure booty for our museum, if not, and then unpardonably, for ourselves. As an animal becomes rare, the commercial " collectors " close round about it, and the scientific experts are sometimes not far off. Public opinion should insist on the licensing of both. This is one of those problems in reference to which it is important to take a world outlook. The extermination of a walrus or a musk-ox, a quagga or a sea-otter, is more than a national or continental loss, it is an impoverishment of the whole world; and we fail to see why every big museum should help to exterminate by insisting on having a full complement of the vanishing rarities.

Perhaps we may seem unnecessarily vehement, but we were just reading a few sentences taken from Sir James Barrett's " *Save Australia* " (1925). Speaking of the Australian birds and mammals, he says:—" Except in certain places where enlightened citizens have protected them, they are all disappearing. It is difficult for anyone to show a visitor in the State of Victoria the larger marsupials or the lyre bird. It is quite impossible to find the smaller marsupials except in a few favoured places and with great trouble. It is, indeed, feared that some varieties have been exterminated." We are not pleading for an impossible humanitarianism in reference to animals that have become (or, oftener, have been allowed or even encouraged to become) *pests;* but we have confidence in appealing to a farm-constituency, notably healthy-minded as well as healthy-bodied, to lean their weight against the extermination of irreplaceable treasures of life.

Fighting against Moths.—It is interesting to get from time to time reports of the measure of success that is rewarding the tactics pursued in combating destructive insects. Some egg-clusters of the gipsy moth were introduced into the United States in 1869, and in twenty years the numbers had so increased that there was very serious defoliation of trees by the voracious larvæ. There was rapid spreading of the pest from place to place. Now, however, there seems to have been successful eradication in Canada, and considerable reduction in the States. The methods used include the importation of natural enemies, the usual spraying and the like, and the setting up of a barrier-zone, 25 to 30 miles in breadth, which has greatly checked the westward spread of the gipsy.

In regard to another alien, the Brown-tail Moth, first noticed in Massachusetts in 1897 and soon spreading very rapidly and widely, preventive checks in the States have been even more successful than in the case of the Gipsy Moth. The importation of natural parasites has proved very effective. There is of course nothing new in all this; we are referring to it simply because the experts have been recently reporting progress in an encouraging way.

Are there Hormones in Plants?—One of the most convincing—perhaps we should say quite convincing—indications of the existence of hormones or chemical messengers in plants is to be found in the studies of Snow and of Ricci on the Sensitive Plant. These independent investigators conclude that the stimulus which travels from an irritated leaf to another part is of the nature of a hormone, comparable, let us say, to the adrenalin that is rapidly carried away by the blood from the supra-renal capsules of a mammal and distributed throughout the body. Or think of the several (perhaps six) hormones secreted by the pituitary body, one of which, in the case of the frog, evokes colour-change when the blood rushes it to the skin.

But our question is: Are there hormones in plants, and we wish to cite a cogent piece of evidence brought forward by W. T. Swingle. It concerns the pollination of the Date-Palm, where, as in some other plants, the pollen exerts a direct influence on the seed and the fruit, apart from its primary function in introducing the fertilising nucleus which unites with the egg-cell, and apart from its other somewhat puzzling function in promoting the development of the nutritive endosperm round about the embryo. What happens in the date-palm is that some subtle influence from within saturates into the seed and the fruit, and affects the size, the shape, and the colour of the seed, and the rate of the fruit's development. That this subtle influence comes, to begin with, from the pollen is proved by utilising different varieties of male palm. Each kind of pollen has its specific effect on the female flowers, even when these are of different varieties.

Swingle's theory is that a specific hormone or analogous soluble substance is secreted after pollination by the embryo-sac, or by the endosperm, or by both, and saturates out into those tissues of the mother-plant that form the fruit and the extra-embryonic parts of the seed. The phenomenon is called *metaxenia* to distinguish it from *xenia*, where, as in Indian corn, hereditary elements or chromosomes introduced by the pollen grain (from a male plant of a different variety from the female) exert a specific influence on the nutritive endosperm. For in metaxenia the pollen-chromosomes are not to be found in the affected tissues of the seed and fruit.

Individuality of the Blood.—The late Mr. George Sim, an old naturalist in Aberdeen, used to be able to identify any common British fish from a square inch of the skin, for the microscopic features of the scales differ from species to species. Similarly, we have seen a good ornithologist identify a bird from a feather it dropped as it flew overhead. This is what is called *specificity*, and we have repeatedly referred to it. A kind or species of animal or plant is itself and no other; and it is often unique through and through, even to the number of nuclear elements or chromosomes found in the nucleus of each of its cells.

On the other hand, there is *individuality*, in the sense that every individual organism is unique, with peculiarities of its own. The term is often used to mean the personality or the peculiar features of an organism, as when we ascribe to a man or to a horse " a strong individuality." But we are using the word here to mean the uniqueness of each individual, a very good instance in man's case being the pattern of the finger-prints, which are different for each one of us, except sometimes in the case of identical twins.

We have recently read of a very striking case of this individuality, worked out by Mr. Charles Todd, F.R.S. In the case of the domestic fowl he has found it possible, by means of simple immunity reactions, to differentiate the red blood corpuscles of any particular fowl from those of any other individual of the same species, except in certain cases where there is close blood-relationship. It is rather an achievement, we think, to be able to prove that the red cells of any individual fowl possess individual characteristics distinguishing them from those of any other individual not a close blood-relation; and it looks as if this individuality applied to most of the other cells of the body. Moreover a comparison of the red cells of chicks with those of possible parents allows in some cases the identification of at least one of the parents. Thus, if the methods develop, there may be a possibility of proving paternity by an examination of the red blood corpuscles. Brother chicks can be distinguished in similar ways; in fact no two chicks have exactly similar corpuscles. This is a foundation stone in the establishment of a doctrine of organic individuality.

THE PIG INDUSTRY IN SCOTLAND.

R. G. M'CLYMONT, M.A., B.Sc. (Agr.).

IN order to measure the importance of pigs as compared with other productive classes of live stock it is convenient to express each in terms of a common unit. For this purpose a cattle beast is commonly regarded as equivalent to seven sheep or five pigs. Using this basis the importance of pigs may be expressed as a percentage of the total live-stock units; and as a result it is seen that in Scotland as a whole pigs have occupied a comparatively unimportant place in the live-stock policy of the country. At the beginning of the period they represented only 1·5 per cent. of the total, and even this small proportion declined slightly to a stable figure of 1·2 per cent. between 1890 and 1910, since when it has risen again to 1·5 per cent. It must be admitted that this comparison of the number of pigs with the number of cattle and sheep on the 4th of June is somewhat unfair to the pig on account of its greater prolificacy, but even if we double the resulting figure—which makes more than an adequate correction—3 per cent. cannot be regarded as an important proportion of the total live stock in the country.

The annual average production of meat in Great Britain during the period 1921-25 has been estimated as follows [1] :—

	Scotland.		England and Wales.	
	Thousands of cwt.	Per cent. of total.	Thousands of cwt.	Per cent. of total.
Beef...	2,805	66·4	6,866	46·0
Veal	55	1·3	609	4·1
Mutton and lamb...	1,085	25·7	2,411	16·2
Pig meat ...	280	6·6	5,026	33 7
	4,225	100·0	14.912	100·0

The position of Scotland is seen to be in marked contrast to that of England and Wales in that while Scotland produces 29 per cent. of the beef produced in Great Britain and 31 per cent. of the mutton and lamb, her contribution to the total production of pork and bacon is only 5 per cent.

The total value of the produce sold off farms or consumed in farm households in Great Britain and Ireland in 1925 was estimated as follows [1] :—

	Scotland.		England and Wales.		Northern Ireland.		Irish Free State.	
	£000's.	Per cent. of total.	£000's.	Per cent. of total.	£000's.	Per cent. of total.	£000's.	Per cent. of total.
Gross value	48,660	...	225,330	...	15,073	...	64,757	...
Pigs ...	1,450	3·0	26,790	11·8	1,399	9·4	9,874	15·2

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[1] Agricultural Output 1925.

Once again the importance of the pig in Scotland is seen to be small and in marked contrast to that in other parts of Great Britain and Ireland.

The 233 farm accounts received by the Department for the years 1928-29 and 1929-30 under the scheme for the Investigation of the Profitableness of Farming in Scotland include in each year only one case in which pig production is the main enterprise, and apart from this more specialised type of pig farm the remainder may be regarded as a random sample with respect to pig production. The two cases referred to might otherwise be described as an arable farm selling some milk, and a dairy farm. The cost of purchased foods is in each case over 40 per cent. of the total expenses other than live stock, and this is a considerably higher proportion than is found in any of the more general type-groups dealt with in the Report on the Profitableness of Farming in Scotland 1928-29. In this connection it is clear than any considerable increase in the number of pigs in Scotland must involve the production of additional feeding stuffs in this country—which is contrary to the existing tendency—or their importation from abroad.

Among the remainder it is in the accounts of the group of cheese-making farms in the South West Area that pigs assume the greatest significance. Almost every cheese farm has some pigs; on about half of these the production of pigs amounts to more than 10 per cent. of the total production, and the average for the whole group is 10 per cent. On the other dairy farms selling whole milk, both in the South West and in a small group in the North East, pigs are of much less importance, accounting on the average for less than 1 per cent. of the total production and appearing on only about half of the farms. In the North East area pigs are found on about three-quarters of the farms, other than those mentioned above, but they comprise only 6 per cent. of the total production in the " cattle-rearing " group and less than 3 per cent. in the " cattle-feeding " group. In neither the " arable " nor the " semi-arable sheep " groups of the Eastern area have pigs a significant place in the farm economy, contributing rather less than 1 per cent. to production in the " arable " group and under 2 per cent. in the " semi-arable sheep " group.

Thus the pig plays a relatively small part in Scottish farming. Compared with other Scottish agricultural produce the value of Scottish pig products is small. In only a few districts in Scotland do the receipts from pigs make a material difference to the total farm income. It is important that the reasons for this should be understood in order to avoid the danger of setting our expectations of any future improvement at an unreasonably high level, and that any attempt which may be made to effect such improvement may not be misplaced or diffused, but concentrated on those circumstances and conditions under which pig-keeping in Scotland does stand a reasonable chance of success.

Within their comparatively small aggregate the numbers of pigs in Scotland show wide annual fluctuations, much greater than those of other classes of live stock. Thus in 1924 there was the highest total on record, 198,836, the number fell sharply to 145,419 in 1926, and rose again to 196,613 in 1927, while in 1929 the total figure of 142,217 was the smallest since 1920. So characteristic is this rise and fall that a " cycle " of pig production is a recognised feature of the pig industry throughout the world. In England and Wales the Ministry of Agriculture speaks of a five year period. In U.S.A. a four to five year cycle is recognised, and in Germany one of three to four years.

The Scottish farmer may be said to keep a few, or a very few pigs, according to his idea of the future trend of prices. But of all the live stock on the farm the stock of pigs can be most rapidly increased, since litters are not only large, but biannual, and maturity is early. This encourages a natural tendency for farmers to endeavour to come in at the " top of the market." The resulting " in and out " policy, itself a sign of weakness, is always extremely difficult to practise with success as in a period of high prices production is rapidly carried beyond the immediate need, prices in consequence break and stocks are just as quickly reduced, while the only person to have benefited is the one who was in at the start.

Economically these fluctuations are significant. Price changes always have most effect in those cases where production is carried on under the least favourable conditions, since then a small price change may mean the difference between a profit and a loss. They therefore imply that in Scotland the margin of profit on pigs is narrow or closely associated with the price of purchased feeding stuffs.

Quinquennial averages which smooth out the more extreme annual variations show that during the past fifty years the number of pigs in Scotland has not increased, despite the much greater demand for pork and bacon which has resulted from the considerable increase in the population during the period. The same applies to England and Wales, whereas the number of pigs in Denmark has increased five-fold, and in Holland has more than doubled in the same period

The fact that the almost insignificant increase in the number of pigs in Scotland during the past fifty years conceals, however, changes of greater magnitude in the various districts has been pointed out by Sir Robert Greig and Dr. J. S. King in an article in this Journal for July 1929 entitled " The Distribution of Live Stock—Fifty Years' Changes." It was there shown that the largest gains have occurred in the lowland and arable districts of the East and in the dairying districts of the South West, while the greatest losses have taken place in the crofting counties, and particularly in Shetland and Skye, where the pig has for all practical purposes disappeared.

The numbers of live stock in each of the various counties in Scotland on the 4th of June 1929 indicate that pigs are to-day most important in comparison with cattle and sheep in the counties of Midlothian (5·6 per cent. of the total live stock units), Wigtown (3·3 per cent.), Renfrew (2·3 per cent.), East Lothian (2·2 per cent.), and West Lothian and Moray (2·0 per cent.); and least important in Shetland (0·1 per cent.), Sutherland and Selkirk (0·2 per cent.), Inverness (0·3 per cent.), and Argyll and Peebles (0·4 per cent.).

The prominence of Midlothian, coming as it does before even the cheese-making counties, is largely due to the extensive use made of hotel, restaurant and shop swill or brock from Edinburgh, to the number of breweries in the vicinity which provide a source of cheap waste products for feeding, and to the proximity of Leith, where imported feeding-stuffs are relatively cheap. These favourable circumstances have given rise in Midlothian to a considerable number of large pig-feeders peculiar to the Edinburgh district. In the cheese-making districts whey forms a valuable by-product which can be utilised only by feeding to pigs. On the other hand the counties at the lower end of the scale have a very high proportion of mountain grazing, very little arable cultivation, and are situated at some distance from large centres of population and the ports of import for feeding-stuffs.

Pigs then have shown no tendency to increase over a period despite an increasing demand for pig products. They form an extremely small proportion of the productive live stock in the country; they reach their greatest significance on the cheese farms where they form part of a joint enterprise with cheese in the disposal of milk; the areas in which the proportional increases have been greatest are the arable and dairying districts, and to-day they are relatively most important in those districts where waste or by-products suitable for feeding are most likely to exist.

With these facts in mind we may now turn to the question of why the pig plays such a relatively small part in Scottish farm economy. Its efficiency as a converter of foodstuffs into live-weight increase cannot be denied, yet the Scottish farmer prefers to use cattle and sheep for this purpose. A certain amount of unreasonable prejudice against the pig may still exist and there may be some difficulty in getting suitable labour to attend to pigs, but the real reason lies deeper than this.

The problem of producing at home a proportion at least of the £63,000,000 worth of pigs and pig products imported from abroad has occupied the attention of agriculturists for a number of years. But it is significant of the economic difficulties to be met that no real progress has been made in effectively increasing the pig population of the country, particularly as in a period such as the present farmers are not likely to have overlooked any possible source of profit.

While home production has not kept pace with the increase in population, imports have increased to such an extent that to-day we are dependent on overseas supplies for almost two-thirds of our requirements, and Great Britain is now the greatest importer of pig products in the world. This represents a development over a period of more than 90 years. In 1840 Great Britain was actually an exporter of pig meat, but gradually the demand exceeded the home supply and recourse had to be made to the United States. After 1880 the dependence of this country on American supplies diminished with the growth of imports from Canada, Denmark, Sweden and Russia, with the result that while to-day U.S.A. still supplies 80 per cent. of the hams imported, Denmark now supplies 60 per cent. of the very much larger quantity of bacon. With regard to fresh pork, Holland took the place of Denmark in displacing U.S.A. up to 1926, when an embargo was placed on the import of fresh pork carcases from Continental sources as a preventive measure against the introduction of foot and mouth disease. Since then the Irish Free State has had a monopoly of this trade.

The reasons for these developments are not far to seek. In the United States pigs represent about 10 per cent. of the total value of the agricultural produce, and about two-thirds of the commercial pork production takes place within the " corn belt." This area of the Middle West is one in which climatic and other conditions are peculiarly favourable to the production of maize by what still amounts practically to the exploitation of accumulated natural fertility. The position as regards maize production in the Middle West thus corresponds to that of wheat further west. In U.S.A. the maize crop and pork production are closely related, and it has been estimated that 30 per cent. to 40 per cent. of the maize crop is marketed in the form of pig products, mainly pork and lard. The corn-hogg ratio is subject to constant adjustment according to prevailing prices, but the pig is an essential factor in the marketing of the maize crop and exercises a levelling influence on the price obtained. The possession of an almost unlimited supply of this valuable pig food at minimum cost places the American producer of pig products in a position with which the pig feeder in this country can scarcely hope to compete in respect to the higher priced portions of the carcase—the hams—and lard, which the feeding of large quantities of maize produces in quantity.

The growth of the pig industry in Denmark provides an example of an industry built up to meet the requirements of a foreign demand in association with a dairy industry which has not a large market for whole milk. In point of exports from Denmark pig products are now second only to the dairy products with which they are closely linked, and the importance of the British market is emphasised by the fact that over 90 per cent. of the bacon exported from Denmark is shipped to the United Kingdom, and this represents about two-thirds of the total annual production of pig meat in Denmark. In this case the producer of pig products in this country has to meet severe competition from peasant labour, which even by dint of hard work and widespread co-operation attains only a relatively low standard of living, and Denmark being primarily an agricultural country there is no alternative use to which this labour can be put.

In Holland and Ireland pig breeding is closely linked with butter-making. In Germany and Ireland again pig feeding is closely associated with potato growing. Even the fact that in England pigs are relatively more important than in Scotland is connected with the greater proportion of the land devoted to arable cultivation, dairying and fruit and vegetable growing, which leave a surplus of non-marketable waste products for pigs to consume.

The success or otherwise of pig-farming under present conditions of world production appears therefore to depend on the availability of products otherwise unmarketable which can be utilised in reducing to a minimum the feeding cost, which is the largest item in the total cost of pig production. The countries which are our greatest competitors in the home market as well as those areas where pigs are relatively most important within our own country all provide this essential basis for a successful pig industry.

The pig, generally speaking, fulfils one of two functions. It is either a consumer of waste products—doing in a different way what swine used to do towards cleansing the medieval village of its refuse heaps—or it forms one element of a joint enterprise. In the former capacity it is a consumer of farm, industrial or domestic waste products, and hence its association with arable rather than grass farming, particularly where potatoes and barley are staple products, and its relative concentration near large centres of population where hotels and breweries offer cheap waste products for feeding. In the latter capacity cheese-making and pig-feeding in the dairying districts of this country provide joint enterprises, and the economic strength of each is increased by their combination.

Conditions in Scotland do not offer a wide field for development in either capacity. Much of the land lies at too great an elevation. The live stock industry is becoming more and more associated with grass, which reduces the waste products available for feeding to pigs. The dairy industry, except in the more remote regions, caters particularly for the whole milk trade rendered possible by the proximity of large industrial centres, thus depriving the pig of its opportunity of acting as a joint product with butter and cheese. The most favourable circumstances for pig-feeding in this country clearly occur on the cheese farms and in the vicinity of the larger towns where swill and brock are available. But this gives rise to a more or less seasonal supply in the aggregate and induces the curer's complaint that the supplies available in this country are irregular in both quantity and quality, and thus place him under a severe handicap in producing a standard quality of bacon at a minimum cost.

Severe competition from other sources must always militate against any considerable development of the pig industry in Scotland, despite the importance of such factors as improved breed and type, careful management and feeding, and better marketing facilities, in alleviating the position. This country with its large industrial market close at hand provides a better standard of living, both for the farmer and farm worker, by the sale of milk and other farm products in their original form or as beef and mutton than could be obtained by introducing the pig as a joint enterprise in their utilisation. It is not the pig nor yet the farmer that is to blame, but simply that in Scotland pork and bacon do not as a rule provide such a wide margin of profit as do alternative products.

INSECT PESTS.—No. XII.

R. STEWART MACDOUGALL, M.A., D.Sc.

THE TWO-WINGED FLIES OR DIPTERA.

THE Order Diptera is rich in species, there being about 3,000 different kinds of flies in Britain alone. This Order is characterised by the possession of two membranous flying wings (some species lack wings), with—on the next joint of the fore-body—a pair of complex sensory structures known as halteres or balancers. The mouth-parts are not fitted for taking solid food but for a liquid diet, this being the sap of plants, or honey, or blood. There is great variation in the mouth-parts; in some the proboscis is soft and in others hard and strong, fitted for piercing as well as sucking. The metamorphosis is complete, the larva from the egg being quite different in appearance and habit from the adult, and so rendering a pupal or resting stage necessary in the life-cycle. The larva is most commonly a legless maggot, with pointed head end provided with mouth-hooks that serve in feeding and progression, and a thicker blunt hind end with conspicuous spiracles; behind the head on each side there can be a fan-shaped spiracle, too small to be seen with the naked eye; this legless larva is often capable of active movement by means of bristles or rows of spines or rough projections. In some families the larva has a better developed head end, with head and horny jaws, and the spiracles may be in a row along each side.

The pupa may be mummy-like or barrel shaped, and some of the mummy-like pupæ are surrounded by a cocoon of varying material. The adults from the mummy-like pupæ escape through a T shaped opening, those with barrel-shaped puparia or pupal cases by means of a round opening at the front end.

There is great variation in the Diptera in habit of life. The adult flies may be blood-suckers attacking men and domesticated animals, sometimes also carrying and spreading disease;[1] some are predaceous, chasing and catching other flies, e.g. the

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[1] The Flies injurious to Stock were described in the Journal of the Board of Agriculture for Scotland in the volume for 1928.

Robber Flies and the Yellow Dung Fly, and some Empidæ where the males offer their booty to the females, who suck the blood of the victim while pairing; still others visit flowers for nectar, and so prove useful in the pollination of flowers; others visit refuse and carrion and excrement for the purpose of laying their eggs, and may carry infection from such places to milk and cured meats and comestibles.

The larvæ may be parasitic on man and other animals, or be harmful to agricultural crops, to garden crops, to fruit, to seed, and also harmful in forestry; other larvæ are scavengers, feeding on refuse, carrion and decaying matter generally. Two families are from man's standpoint useful and they may be looked at before reviewing the principal Dipterous enemies of agricultural crops.

Useful Flies.—*The Family Tachinidæ.*—The flies of this family look more or less like very hairy or bristly house-flies. Their larvæ are internal parasites of caterpillars of various kinds (Fig. 1), and also of the earlier stages of some insects that have an incomplete metamorphosis, e.g. the earwig.

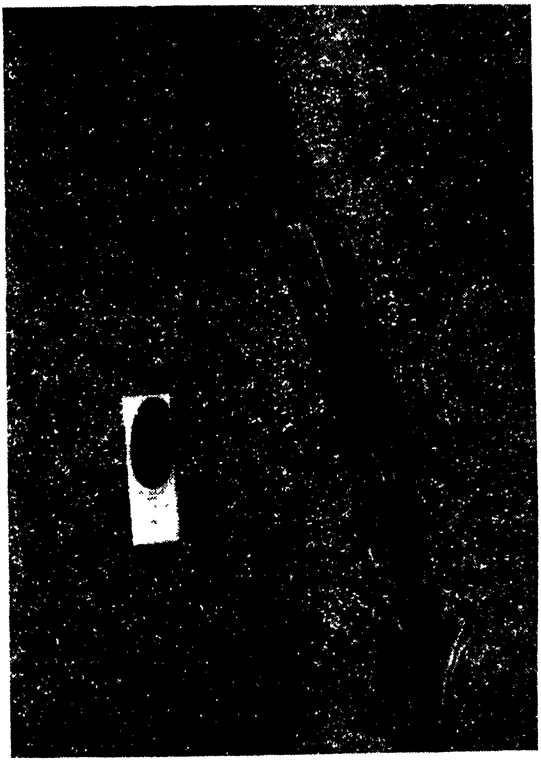

FIG. 1.—Tachinid Fly laying egg on caterpillar. To the left is seen a puparium from which a Tachinid fly has issued. (Natural size.)

The female Tachinid lays her eggs on or near the victim, and the larva on hatching enters the host and feeds at the host's expense, ultimately destroying it; or the parasite may gain entry to the host by the Tachinid fly laying her eggs on the host's food plants; the eggs are swallowed with the food and the Tachinid maggot hatches internally. Tachinid larvæ are maggot-like, rather rounded and somewhat flattened on the under side. The puparium is oval with the two ends rounded.

The Family Syrphidæ.—This is a large family with members of varying habit. The larvæ may be carnivorous, preying on greenfly and small caterpillars; in some species the larvæ are harmful to plants and in other cases they are scavengers; some live in bulbs, some in fungi and some in the nests of bees and ants.

The species of the genus Syrphus and allied genera are useful inasmuch as the larvæ prey upon Aphides. They are known as hover-flies or flower-flies. They have a habit of hovering over flowers, their wings in rapid vibration, the flowers being visited for their nectar or their pollen; in colour they are black or brown with yellow transverse bands, the colour and appearance suggesting wasps, for which these flies are sometimes mistaken.

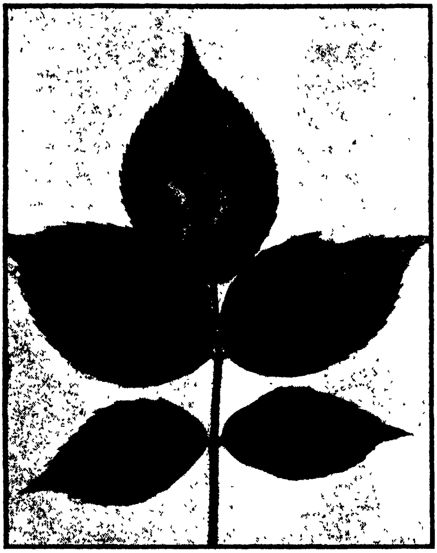

FIG. 2.—Syrphus Fly larva on roseleaf infested with Greenfly.

The female hover-fly lays her eggs singly on leaf or shoot, choosing a place where there is a colony of greenflies. The larva from the egg is a legless maggot dirty-white or dirty-green or brown-green in colour, sometimes with a distinct line traceable down the middle. In progression the larva fixes its mouth-hooks in a leaf, and then brings forward the hind part of the body towards the head end and then fixes this, the body in this stage being looped; next the mouth-hooks let go their hold and the body is extended. The body is thicker and broader behind, especially when extended in feeding or moving, at which time the front end is drawn out to a point. (Fig. 2.)

The mode of seizing the prey is interesting. The larva is blind, but extending its head and keeping the hind end fixed it gropes for, or strikes here and there for its prey, which is perhaps recognised by touch or smell. The soft-bodied greenfly, seized by the mouth-hooks of the hover-fly maggot, is held aloft and having been sucked dry is dropped away. These hover-fly larvæ are very voracious, and serve as one of nature's checks to the increase of aphids.

Flies harmful to Crops.—*The Gall Midges.*—The Gall midges or Cecidomyidæ are small to very small insects, delicate and slender. They are distinguishable as species only by the specialist and pass practically unnoticed by the ordinary observer. As family characters we may note the following :—the wings are large for the size of the insect, narrowed where they spring from the body and then broad; the antennæ are many jointed; the legs are long and slender; the male besides having handsomer antennæ has a clasping or fixing organ at the hind end, while the female has an ovipositor or egglaying tube, sometimes short and weak in the species which lay their eggs on the external surface of leaf or stem, but long and able to be extended and telescoped in species that lay their eggs in plant tissue or in more or less protected places. The larva is a very small maggot, cream-coloured or yellow or pink or red; it has 14 joints, that is one over the typical number for insect larvæ, this extra joint being next to the head; the head end is poorly developed, with two minute antennæ and rudimentary mouth-parts used in scraping and sucking; there are nine pairs of breathing pores down the sides of the body. The larvæ of some species can spring. A feature of most of the larvæ is the presence behind the head of a horny structure known as the anchor-plate or " breast-bone," whose function is in dispute; the anchor-plate is elongated with its front end free; the free end varies considerably in shape—pointed or two-pronged or three-toothed and so on—and examined under the microscope often affords useful help in the distinction of species. No larvæ other than Cecidomyid larvæ possess this " breast-bone."

In one genus of gall midges we have the very interesting case of a larva giving rise to other larvæ inside itself; these larvæ break through to the outside and may in turn produce other larvæ until at last the larvæ show the characteristic " breast-bone," become full grown and then pupate to give rise to the adult gall midges.

The habits of gall midge larvæ differ greatly. Most are vegetarian, living in stem or leaf or flower or fruit or seed; some live in decaying matter; some in fungi; many are the cause of galls, others live as guests in galls; a certain number of species live on animal juices, some being internal parasites of greenflies, while others prey on mites and it may be on other gall midge larvæ.

The full-fed larva passes on to the pupal stage. In some cases the pupa is mummy-like; sometimes the last moulted skin of the larva is not thrown away but changes colour, and hardens to form a protecting case or puparium under cover of which the full-fed larva rests for a time and later pupates near the time of adult exit; in still other cases a fine cocoon may surround the pupa. The species that pupate in galls may have pupæ provided with a structure that enables the delicate adult to escape from the gall.

The Gall Midges of Cereals and Grasses.—*The Hessian Fly Mayetiola* (*Cecidomyia*) *destructor.*—This now widely distributed insect is chiefly a wheat insect, barley is sometimes badly attacked, rye more rarely. Of wild grasses Couch (*Agropyrum repens*) appears to be a normal host. A generation ago the damage to wheat crops in the United States and the losses in Central Europe made farmers fear the worst when the Hessian fly was reported at work in Scotland and England in 1886. With time, however, this insect has ceased to cause a scare. Its comparative harmlessness in Britain is due partly to climate and to our culture methods, which are partly determined by climate. In the United States there is a dangerous attack on the autumn-sown wheat, the young plants being ready for the egglaying of a brood of the flies issuing then. Such young plants are often completely destroyed. With us not only is the wheat sown later, but on the average we have only one chief brood of the Hessian fly in the year, the adults of which issue in very late spring or early summer from the puparia which have overwintered. In Scotland the Hessian fly has been recorded from the Moray district, from Inverness-shire, Perth and from the Lothians and neighbourhood. In 1906 there was a severe attack on barley in parts of Aberdeenshire and Banff, in some places 20 per cent. of the crop being affected; the grain on attacked plants did not ripen well, and where tillers were formed they were short and late and had poor heads.

The female lays her eggs along the upper surface of the leaves between the veins. A number of eggs may be laid on the same leaf. The larva on hatching moves down the leaf—there is some mortality during this stage—to between the leaf-sheath and the stem. The juices of the young stems are tapped and the stem weakened. Favourite places for the collecting of the larvæ are the first and second joints above ground, and here in time the puparia or " flax-seeds " are found. The outer skin of the full-fed maggot becomes hard and brown, and under cover of this puparium, which has a resemblance to a flax-seed, the larva passes the winter and pupates in the next late spring.

One result of the infestation by the larvæ in summer is a weakening of the attacked stems, which become elbowed, bending over at the nodes just above the sheltering place of the puparia; the ears of such stems are poor.

The screenings containing the puparia or " flax-seeds " that have fallen away in threshing should be destroyed. A deep ploughing would account for such puparia as had been left in the stubble. Some active parasites assist in keeping the Hessian fly in check.

Haplodiplosis equestris.—This Cecidomyid, also an enemy of wheat, has been recorded, with complaint of damage, from different districts in England. It is sometimes confused with the last as regards larva and nature of damage. The two may be thus distinguished :—

M. destructor.	*H. equestris.*
Female lays eggs on upper surface of leaves of lowest or next lowest joint.	Female lays eggs on upper surface of topmost leaf.
Larva pale reddish on hatching, later white.	Larva red.
Larva migrates from blade to the protection of the leaf-sheath.	Larva migrates from blade to the protection of the leaf-sheath.
Stem weakened at place of feeding and may lodge.	A gall or swelling marks the feeding-place of a larva. Each swelling is cushion-like with a saddle-shaped depression. A number of such swellings may be in line, each with its larva. The leaf sheath is swollen at such places.
Full-fed larva does not leave the plant for pupation.	Larva when full fed, at the time of the ripening of the wheat, falls away and enters the soil for pupation.

The Wheat Midge (*Contarinia tritici*).—The larvæ of this species are destructive to the grain, poor shrivelled samples resulting when the larvæ in a flower have been small in number, and no grain at all from a flower where the larvæ have been numerous. This midge has been recorded both from England and Scotland. The female in summer lays her eggs, in groups, in flower heads, inside the pales or bracts, being aided in this by her pointed ovipositor. The larvæ on hatching nourish themselves on the reserve supplied to the ovary for the development of the grain. The full grown larva leaves its sheltered position in the middle of the flower and passes to the ground. This movement may be an active springing movement. Pupation takes place later in the soil. The larvæ leave in July, and the next brood of adult midges issues in May or June.

The larva is golden yellow in colour. Attention is drawn to infested ears by their withered yellow colour.

How important a knowledge of the life history may be, when control is founded on it, receives excellent illustration in the case of this Wheat midge. The old recommendation was to burn the screenings at threshing time in order to destroy the Wheat midge pupæ. More careful observation, however, showed that the larvæ or pupæ which remained in the ears and were found in the chaff were unhealthy parasitised ones, and that destroying such screenings meant destroying the useful parasites.

The Foxtail Grass Gall Midges.—All interested in Meadow Foxtail " seed " know how poor a sample may be, and this is greatly due to the work of Gall midges. It is only recently that the story of these insects has been carefully worked out in

Britain by Dr. H. F. Barnes [1] of Rothamsted. There are three species infesting Foxtail and these will be best understood if in tabular form I summarise Barnes' work. The larvæ of the three species destroy the seed, or the essential organs concerned in seed production.

Dasyneura alopecuri.	*Stenodiplosis geniculati.*	*Contarinia merceri.*
Larva orange to brick-red in colour.	Larva pale buff to salmon pink.	Larva bright golden yellow.
Pupa clear or glassy-like.	Pupa with front part dark, hind part clear.	Pupa with front parts rather darker than hind parts.
One larva to a flower and the seed is shrivelled and spoiled.	One larva to a flower.	A number of larvæ to the flower ; the formation of seed prevented.
Females active from end of April to July.	Females appear in April and May and a second brood in June to August.	Females active from May to July.
Eggs laid on outer surface of the bract or scale enclosing the flower, and the larva on hatching climbs into the flower. Larva feeds for two months and passes the winter as larva in the spoiled grass, fruits or flowers. For the issue of the fly the pupa wriggles up from the affected flower ; a slit appears in the pupal skin and the adult emerges.	The full-grown larvæ remain for pupation in the spoiled grass, fruits or flowers.	The full-grown larvæ leave the flower-heads and pass to the soil for pupation.

Control.—By cutting or grazing prevent the grass from flowering until such time as this can be done without risking flower and seed production for the year. Barnes quotes Miss Rostrup's methods of killing the larvæ in the harvested ears. To ensure that only midge-free seed is sown, expose the seed for thirty-five minutes to a temperature of 50-60° C. dry heat; or fumigate with bisulphide of carbon (note that the vapour is poisonous and inflammable), 1 gram of bisulphide of carbon to a litre of air; keep the fumigating receptacle or chamber air-tight for nine hours.

Gall Midges of Clover and Pea.—*The Red Clover Gall Midge (Amblyspatha ormerodi).*—So far this species has only been recorded from Britain. It was named as a new species by Kieffer in 1913 from adults which I reared from infested red clover that came to me from nearly a dozen English counties.[2] Since then Theobald reported it unusually injurious in Kent; Cunliffe has found it very harmful in Herefordshire, Jenkins in Wales and Taylor in Yorkshire. The larvæ are red or orange-red.

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[1] Students should consult :—" Control of the Meadow Foxtail Midges," by H. F. Barnes in the *Journal of the Ministry of Agriculture*, Vol. XXXVII, Oct. 1930; and " British Gall Midges of Economic Importance," by H. F. Barnes, B.A., Ph.D., in the *Journal of the South Eastern Agricultural College*, Wye, Nov. 1927; and also in *The Annals of Applied Biology*, Vol. XVII, May 1930.

[2] The Red Clover Gall Mite, by R. Stewart MacDougall, in *Journal of the Board of Agriculture*, London, vol. xx, 1913.

The eggs are probably laid on the unopened buds or on the young leaves (in confinement eggs were laid on the young leaves of clover offered to the females).

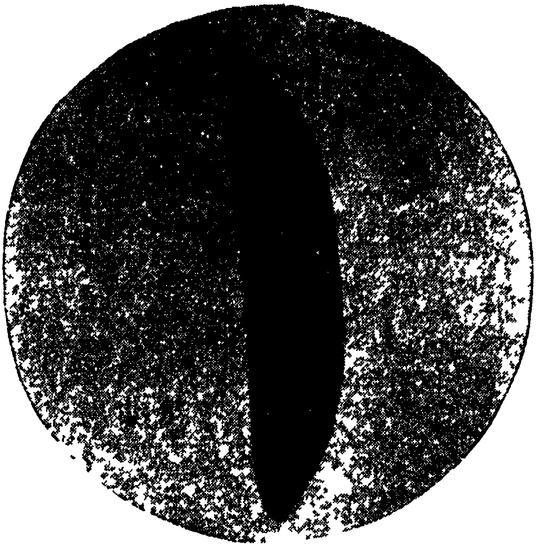

FIG. 3.—Larva of *Amblyspatha ormerodi*, greatly magnified. The dark object just behind the head is the anchor plate (From Nature.)

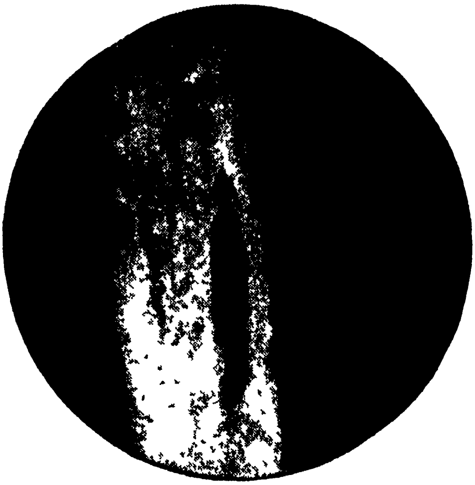

FIG. 4.—Larva of *Amblyspatha ormerodi* on Red Clover. (From Nature. Magnified.)

The red larvæ were found in the following places :—

(*a*) At the apex of the plant at ground level; in such a position, in one case, up to 30 larvæ were found.

(*b*) In some of the withered and brown side-shoots; in these six to eight larvæ were found. The pith was hollowed out and the shoots deformed. (Fig. 4.)

(*c*) In unopened leaflets. The stipules were dead and the leaflets discoloured.

(*d*) In unexpanded buds.

> (*e*) Occasionally in the primary root, at the junction of root and stem; in one case two live larvæ were found almost two inches down into the tap root. In larger, stronger plants the tap root escaped damage or was affected only where it joined the stem.

The larvæ pupate in the soil in the neighbourhood of the plants.

While working with this species I sometimes found larvæ of the fungus-gnat family (Mycetophyllidæ) alongside of the Cecidomyid larvæ. Fungus-gnat larvæ are common where there is rotting plant matter, and they are common in fungi, as some Cecidomyid larvæ also are. The fungus-gnat larvæ, however, are easy to tell by their very well-developed head.

The Clover Seed Midge (*Dasyneura leguminicola*).—In the United States and in Canada this species has been the cause of great loss in clover seed; it has been recorded from England and Wales. The females lay their eggs in the opening flowers of red clover, with the result that the flowers do not properly open out and no seed is formed. The full-grown maggots leave the spoiled flowers and pass to the soil for pupation, which takes place under cover of a delicate cocoon of silk entangled in which are particles of soil. White clover and alsike clover may also be attacked.

The Clover Leaf Midge (*Daryneura trifolii*).—This species has been found in England, Scotland and Wales. The female lays her eggs in the leaves of white clover before these have expanded. The larvæ—white at first but orange coloured when grown—live between the folded leaflets, which do not open up but become swollen and brown. The leaves chosen for the egg-laying are low down on the plant. The full grown larvæ pupate in the swollen leaflet under cover of a cocoon of silk. The Clover Leaf midge lays also on red clover, but the species is not a serious clover enemy.

The Pea Midge (*Contarinia pisi*).—This species, well known in Central Europe and in Sweden, has also been found at work from Northumberland southwards to Kent. Barnes [1] has worked out its life-history in England. There are two types of damage; in one the larvæ are destructive to the flowers and shoots; attacked terminal shoots are dwarfed and the flowers misshapen and unfruitful; in the other type of damage, later in the season, the larvæ are found inside the pod feeding on its inner surface. In both cases the larvæ are gregarious, almost a hundred having been counted inside one spoiled flower and up to three hundred in a single pod. In the last case there is risk of the larvæ appearing at table.

The larvæ are white and have a springing or leaping habit.

Barnes has described another species found in peapods, viz.

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[1] The Gall Midges of Peas, by H. F. Barnes, B.A., Ph.D., in *Bulletin of Entomological Research*, vol. 19, 1928 29. British Gall Midges of Economic Importance, by H. F. Barnes, B.A., Ph.D., *Journal of S.E. Agricultural College*, Wye, No. 24, July 1927.

Lestodiplosis pisi. The larva of *L. pisi*, which has no anchor-plate, preys on the larvæ of *C. pisi.*

The Swede Midge (*Contarinia nasturtii*).—In addition to the swede, other cruciferous plants, cultivated and wild, act as hosts of this insect. The nature of the damage to swede has been described by Taylor,[1] whose account I summarise. The female midges by means of the delicate ovipositor lay clusters of eggs on the upper surface of blade and leaf-stalk, the younger leaves in the heart of the crown being selected. The larvæ on hatching wound the surface of the tissue of blade and stalk. Taylor distinguishes two kinds of malformation, viz. the "many necked" condition and the "crumpled leaf" condition.

In the "many necked" condition the terminal bud is destroyed and dormant buds are called into activity, resulting in a number of secondary necks.

In the "crumpled leaf" condition the terminal bud is not destroyed and the dormant buds remain dormant. The affected leaf stalks, however, swell and bend sharply inwards over the top of the plant and the leaf blades become crumpled, resembling the leaves of the savoy.

Full grown larvæ leave the plant—they can leap—and become pupæ in the soil under cover of a silky cocoon. For the issue of the adult midge, the pupæ break out of the cocoon and wriggle to the surface.

DEMONSTRATION POULTRY CROFT AT KIRKAPOL, TIREE.

Isabella Alexander, C.D.D., C.D.P., and
John Kirkwood, B.Sc.

The West of Scotland Agricultural College, with a view to demonstrating the economic value of poultry in the island of Tiree, made arrangements in 1915 for the establishment of a demonstration poultry centre at Kirkapol. This has been carried on ever since. During this period methods of poultry husbandry have much improved on the island, and the output of eggs has increased greatly. The credit for the advance in these respects has undoubtedly to a very considerable extent resulted from the work carried on at the demonstration centre.

In this article the methods of feeding and management and the results obtained during the two years 1928-29 and 1929-30 are set forth.

The island of Tiree, on the open Atlantic, is exposed on all sides, and often experiences wild and stormy weather. At certain times of the year, especially in spring, the east winds are extremely cold. The soil on most parts of the island, being light and sandy, is dry, which makes it suitable for poultry keeping.

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[1] Cabbage Top in Swedes, by T. H. Taylor. No. 82 of the Publications of the University of Leeds and the Yorkshire Council for Agricultural Education.

One great drawback is the want of natural shelter. There are no hedges or trees on the island.

The farm of Kirkapol is situated in the east end of the island and combines, as far as suitability for poultry keeping is concerned, all the advantages and disadvantages common to the island.

The poultry are kept as a side line to the farm and have proved to be profitable. A flock of from 40 to 50 birds is maintained by rearing about 60 chickens each year. The hatching is done by the natural method of broody hens, and is carried out in the months of March and April. Fertility has always been high and the chickens hardy and easy to rear. The pullets usually begin to lay in September, and the cockerels, which are not specially fattened, are sold to visitors who come to the island.

The poultry are kept on good free range, and are provided with three poultry houses which allow for plenty of light and ventilation and which are kept scrupulously clean. The houses are of wood and are 9 feet long, 7 feet broad and 5 feet high. Dropping boards are placed under the perches and these are scraped and sprinkled with sand every day. In this way the floor and litter are kept clean for the birds to scrape in during stormy weather, when it is impossible for them to get out to forage in the fields. The nest boxes also are kept perfectly clean to ensure clean eggs.

Two of the houses are occupied in rotation during the whole year. The third is kept empty for three months each year. It is thoroughly disinfected before hatching commences, and is then used for rearing the chickens.

The breed of poultry kept at Kirkapol is Rhode Island Reds. This breed has proved to be well suited to the conditions obtaining there. It withstands the cold winds and suits the light sandy soil. The birds are of a good type and colour, are carefully managed, and kept in the best condition possible.

As a rule no stock is bought in except breeding cockerels. These are generally procured from the poultry department of the West of Scotland Agricultural College. Good hatching results have always been obtained.

Feeding of Fowls.—*Grain.*—1½ ozs. of grain, consisting of 2 parts oats, 1 part wheat, 1 part Indian corn is given daily—½ oz. being fed in the morning and 1 oz. in the evening just before the birds go to roost. The grain is scattered on a clean piece of grass.

Mash.—A hopper, containing dry mash, consisting of 1 part bran, 1 part thirds, 1 part oat meal, is open inside the house all day. During cold weather 1 part of Indian meal is included in the mash.

In winter a warm wet mash is fed occasionally. This consists of household scraps, boiled potatoes or turnips, along with 1 part oatmeal, 1 part thirds, 1 part bran, all mixed together with sour milk. Green food is supplied in the form of turnips and cabbages when available. Sour milk or buttermilk is given to drink when plentiful.

No grain is fed on days when a stack of oats or barley is being taken in from the stackyard to the barn. When a stack of barley has been taken in, and the birds have been picking up the fallen grain, it is found that egg production generally rises.

Feeding of Chickens.—No food is given for 48 hours after hatching.

First two days.—7 parts chopped egg, hard boiled, mixed with 4 parts stale bread crumbs.

First six weeks.—Grain is fed at 7.30 a.m., 12.30 p.m. and 8 p.m. Mixture consists of 8 parts groats or pinhead oatmeal, 4 parts small wheat, 1 part kibbled Indian corn. Soft mash is fed at 10 a.m. and 4.30 p.m., and consists of 3 parts oatmeal and 1 part thirds. Occasionally steamed seeds are given instead of the soft mash and the mixture consists of 1 part broken rice, 1 part kibbled Indian corn, 4 parts groats and 6 parts kibbled wheat.

Seventh to fourteenth week.—Soft food is fed at 7.30 a.m. and 4.30 p.m. Mixture consists of 1 part bran, 1 part thirds and 2 parts oatmeal. Grain is fed at 12 noon and 8 p.m. and consists of 8 parts crushed oats, 8 parts small wheat, 4 parts kibbled Indian corn and 1 part Dari. Sour milk is supplied as a drink.

From the fifteenth week the pullets are fed in the same way as the hens.

Financial Results.—An annual statement of accounts is made out on 30th September each year. As space forbids the inclusion of such statements in this article, the more important points only are given.

Valuation of Stock.—At the annual valuation a fixed or standard value for pullets and for one year old hens has been adopted throughout. By so doing it can be claimed that any profits shown are real, and not dependent upon fluctuating market prices for stock at time of valuation. An ample allowance for depreciation of houses is charged.

Feeding Stuffs.—The costs charged are the actual price plus carriage or freight. The costs include the value of home grown grain used, but do not include any charge for pasture, for running on corn stubbles in autumn or for green food used. No value has been credited for the manure produced.

Average number of Eggs per Bird.—This figure is arrived at by taking the total number of eggs laid and dividing by the number of hens at the beginning of the financial year—1st October. Thus, if any hens died during the year, and had not therefore a full laying period, the average of the remaining hens suffered as a result.

Profit.—It was thought better not to include in the statement of actual results hypothetical figures for labour, rent of land used or interest on capital, and no charge has been made in respect of these items. The sum stated as profit is what is left to recompense the poultry keeper for labour expended, rent of land used and interest on capital.

Profit per Hen.—This is arrived at by taking the profit shown in the annual statement as defined above and dividing by the number of hens on hand at the beginning of the financial year. The average price stated per dozen eggs is exclusive of the price obtained for sittings sold.

For the year 1928-29 the average number of eggs produced per pullet was 173 and for second year hens 110. The average price realised for eggs sold (exclusive of sittings) was 1*s*. 6*d*. The profit shown from the 34 head of poultry was £29, 7*s*. 4*d*. or an average per hen of 17*s*. 3½*d*. Thirty-one dozen eggs were sold for hatching at 5*s*. per dozen. If these are credited at ordinary market value, then the profit per hen works out at 14*s*. 5½*d*. Three fowls died during the year.

For the year 1929-30 the average number of eggs produced per pullet was 176 and for second year hens 115. The average price realised for eggs sold (exclusive of sittings) was 1*s*. 6½*d*. The profit shown for the 40 hens was £45, 2*s*. 7*d*., or an average of £1, 2*s*. 7*d*. per hen. Forty-eight dozen eggs were sold for hatching at 5*s*. per dozen. When these are credited at ordinary market value then the profit per hen works out at 17*s*. 9½*d*. The larger profit shown in 1929-30 is due partly to the fall in the price of feeding stuffs, and partly to a greater number of eggs having been sold for hatching purposes.

By comparing the egg production per pullet any one year with that of the hens the following year, the difference in egg production of pullets and the same birds as hens is obtained. This information has been extracted from the records at Kirkapol for the seven years 1923-1930.

The average production per pullet works out at 191 eggs and for the same birds as hens 122 eggs; pullet production therefore exceeded hen production by 69 eggs.

It does not necessarily follow that pullets are more profitable than second year birds, because it is from the latter that hatching eggs are sold. At Kirkapol hatching eggs have realised 5*s*. per dozen. The price obtainable for table eggs at that season is generally about 1*s*. per dozen. Where, as at Kirkapol, a considerable business has been developed in the sale of hatching eggs, then the keeping of birds for a second year would seem to be a sound economic proposition.

The results obtained at this demonstration poultry croft for the seven years 1921 to 1928 were published in Bulletin 116 of the West of Scotland Agricultural College. The average profit per bird for these seven years (calculated on the same basis as for the two years reviewed in this article) was 15*s*. 3¾*d*. No spectacular profits have been obtained at Kirkapol. The noteworthy feature is the consistently good results obtained year after year over a long period.

That poultry keeping may be made a remunerative business even on the outer islands of Argyllshire is clearly demonstrated in the foregoing statement. On the exposed island of Tiree a small flock of about 40 head, of a good laying strain, fed and managed on up-to-date lines left a handsome profit to the owner.

THE AGRICULTURAL MARKETING ACT, 1931.

THE purpose of this Act is to enable the producers of any agricultural product in an area, which may be Great Britain or any part thereof,[1] to frame for Ministerial and Parliamentary approval a scheme setting up a board to regulate the marketing of that product. A scheme may also deal with more than one product. The Act is permissive, not compulsory. But any scheme, when it has passed through the various stages of approval required by the Act, and when finally it has received the support of not less than two-thirds of the "registered producers" voting on a poll, becomes binding upon all producers of the product within the area, unless they are exempted.

In the working of the numerous voluntary co-operative societies set up in Great Britain in the last twenty or thirty years for the purpose of dealing in agricultural produce, three grave defects have revealed themselves. Non-members may enjoy the advantages obtained by a society without sharing the responsibilities of its members, and may even, as in the case of the Scottish Milk Agency, get better terms than members. Members of a society, even when under definite contracts, do not always show consistent loyalty, but may deal through the society or elsewhere as the advantage of the moment may induce them. Lastly, a society or factory cannot reckon on obtaining a steady supply of produce of a uniform grade. Opinion in favour of compulsion, exercised not by the State, but by a substantial majority of the producers concerned, has grown rapidly of late,[2] and this is the fundamental principle of the Marketing Act.

The Bill was originally introduced in the House of Commons on 31st July 1930, and was printed for the purpose of enabling it to be considered and discussed throughout the country during the Parliamentary recess. It was again introduced in an amended form in December 1930. During its progress through Parliament it was substantially altered, and it became law on 31st July 1931. The Bill was thus under discussion for exactly a year, and as finally passed it embodies the results of exhaustive discussion both in Parliament and elsewhere. It may be mentioned that the Bill in its original form covered 19 pages, while the Act covers 34. This expansion is largely due to the insertion of provisions safeguarding the interests of individual producers and of other persons likely to be affected by the working of schemes under the Act.

The Act is to be administered in Scotland by the Secretary of State and in England and Wales by the Minister of Agriculture, while in any matter affecting both countries the two Ministers will act together.

Powers of Boards.—The powers exercisable by boards set up under the Act are given mainly in Sections 5 and 6 (1). Those under the former section are optional, while those under the latter must be included in every scheme.

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[1] The Act does not apply to Northern Ireland.

[2] See, for example, the Report of the Committee on Agricultural Co-operation in Scotland (Cmd. 3567, 1930), pp. 39 and 41.

It must not be thought that a board will assume all the powers enumerated in Section 5. Some of them are indeed mutually exclusive. The section has been drawn up so as to include all the powers that may be exercised by boards of various types, dealing with the various agricultural products. Broadly speaking, there are three types of activity that boards may adopt :—

> (1) A board may actually buy and sell the product, generally by means of a "pool," at prices fixed from time to time. This would be the appropriate method in the case, for example, of milk. This kind of board will also grade, pack, store and otherwise treat the product, and will have power, for example, to produce butter and cheese from milk. Section 5 (*b*) gives such a board complete control of the product or of any kind, variety or grade of it, or of any quantity of it, and the board will then be in a position to exercise the powers given by Section 5 (*a*).
>
> (2) A board of the "regulating" type may act, not as a trading body, but by controlling the operations of producers. They may determine from time to time the kind, variety or grade of the product that may be sold, the price at which (or below or above which) and the persons to whom it may be sold (Section 5 (*e*)), and may regulate the grading, marking, packing, &c., of the product by the producers (Section 5 (*f*)). Such a board may again limit their operations to the latter type of management, without in any way controlling the sale of the products. Thus a board set up for the marketing of cheese or fruit might exist simply for the purpose of guaranteeing that all the cheese or fruit produced in their area and sold under their mark reaches a certain standard of quality.
>
> (3) A board may "regulate" the bulk of the product, for example potatoes, and may themselves dispose of the surplus, in order to prevent such a fall in price as took place in connection with the potato crop of 1929.

In order to ensure the successful working of the scheme, persons authorised in writing by the board will have powers to inspect the land or premises of producers that are used by them for the production, grading, &c., of the product (Section 5 (*g*)). Producers may also be required to furnish to the board such estimates, returns and accounts as are required (Section 5 (*h*)).

A board may not only deal in or control a particular product, but may buy and sell or let for hire to registered producers anything required for the production of the product, such as fertilisers, feeding-stuffs, machinery, containers, &c. There is of course no compulsion on any producer to deal in this way with the Board (Section 5 (*c*)).

Lastly, it is recognised that a board may, besides exercising compulsory or restrictive powers, have an educative function. It is accordingly provided that a board may encourage agricultural co-operation, research and education (Section 5 (*i*)).

The provisions that must be included in every scheme are given in Section 6 (1) and in the Third Schedule.

The first of these is that, whatever may be the type of activity carried on by the board, no sale of the " regulated product " can be made by a producer within the area covered by the scheme who is not either registered or exempted from registration (Section 6 (1) (*a*)). The scheme must accordingly specify, or the board must determine, the classes of producers and the descriptions of sales that are to be exempted (Section 6 (1) (*b*)). The board have power to recover penalties by civil process from persons contravening any of the provisions of a scheme made under Section 5 (Section 6 (1) (*c*)). Any producer who is aggrieved by any act or omission of a board may take the matter to arbitration (Section 6 (1) (*d*)). Lastly, the register of producers must be open for inspection, and a copy of it or of a part of it must be furnished to an applicant on payment of a fee (Section 6 (1) (*e*)).

Section 6 (2) gives a general sanction to the inclusion in a scheme of whatever provision may be necessary to give it effect, with a proviso that no market or slaughter-house may be established under a scheme unless power to do so is specifically included in the scheme.

Section 6 (3) renders any producer selling the product without being registered or exempted liable to prosecution and to the infliction of a heavy fine, part or the whole of which may at the discretion of the Court be paid to the board (Section 6 (4)).

Procedure regarding Schemes.—A marketing board is an authority of a new kind, partly resembling the board of directors of a commercial or industrial company, and partly resembling a local authority with power to levy a rate. In view of the extensive powers that may be exercised by such a board, it is not surprising that the process of setting it up should be long and elaborate.

In the first place a scheme may be drawn up by a body of persons who are " substantially representative " of the producers of a certain product in a given area, and submitted to a Minister for approval (Section 1 (1) and First Schedule, Part I). Alternatively, a scheme may be drawn up by an Agricultural Marketing Reorganisation Commission and laid before the Minister, who may then take such steps as he thinks fit to bring it to the notice of the producers concerned, with a view to their adopting it for submission to him (Section 15 (1)). This Commission is dealt with later in this article.

When the scheme is submitted to him, the Minister must give notice in the " Gazette " and elsewhere of its submission, and copies of the scheme must be available on payment of a fee. A period of not less than six weeks is to be allowed for objections to be lodged (Section 1(3)). The Minister will deal with these objections either by negotiation or by a public inquiry, and if as a result he proposes to modify the scheme he must give notice of the proposed modification to a group of the producers nominated for the purpose (from nine to twenty-one in number). Unless more than half of these assent to the modification, the scheme will go no further (Section 1 (5)). If this condition is fulfilled and the Minister is satisfied that the scheme should proceed, he will, after consulting the Board of Trade, lay the draft scheme before Parliament, and if each House resolves that the scheme shall be approved he will make an order approving it, which will be published in the usual way.

The scheme will then come into force in a limited measure, and the board will be appointed in the prescribed manner. Their first task will be to draw up a register of producers and to grant exemption in appropriate cases. In view of the fact that the next step is the taking of a poll, it is of the utmost importance that every one concerned should be fully informed of the nature of the scheme and that the register of producers should be as complete as possible. For this purpose the Minister must publish in suitable newspapers a form of application for registration, with a notice stating the nature of the regulated product and the area to which the scheme applies, with full particulars regarding registration and exemption and the purpose and effect of the poll (Section 4 (1)). Further, he must have a list compiled of all the persons he has reason to believe are producers, using the Agricultural Returns for this purpose, and send it to the board (or else inform them that his information is insufficient) (Section 4 (2) and (3)). The board must then send to every one on the list and to every other producer known to them a circular in the same terms as the newspaper notice, with a form of application for registration (Section 4 (4)).

If after all this publicity any producer fails either to register or to secure exemption, the responsibility will clearly be his own.

In the meantime, all the compulsory powers of the board are suspended. The board are, however, entitled to borrow from the Agricultural Marketing Fund a sufficient sum to meet initial expenses, including those incurred in taking the poll.

The poll is then taken, and if there vote in favour of it (*a*) not less than two-thirds of the total number of registered producers voting in the poll, and (*b*) registered producers who are capable of producing not less than two-thirds of the quantity of the regulated product that all the registered producers voting on the poll are capable of producing, and if the number voting is not less than half the total number of producers (excluding those exempted or entitled to exemption), then the suspended provisions of the scheme come into force at a time between one and two months after the declaration of the result of the poll (Section 3 (2)).

These requirements are intended to ensure that a scheme shall not be carried on a small poll, or by large producers alone or by small producers alone. It will however be possible for a scheme to be put into force by 34 per cent. of the registered producers (two-thirds of 51 per cent.).

The method of taking the poll is not laid down in the Act, but the Minister of Agriculture, in the course of discussion in Committee, said that he had little doubt that it would be taken by post.

If a scheme is rejected on the poll no expense will fall on the producers concerned, the liabilities incurred by the board up to that point being written off any loan made to the board (Section 13 (2)).

Existing Contracts.—It would be manifestly unfair that on the inauguration of a marketing scheme the contracts previously entered into by producers for the sale of their produce should be rendered void. Section 8 accordingly provides that producers under contract shall have three months to register their contracts with the board, failing which these will become void. The board must register a contract unless they think it was made in order to evade the operation of the scheme, a question that falls to be determined if necessary by a court of law.

Financial Arrangements.—For the carrying on of the scheme the board will be entitled to levy contributions on the registered producers, assessed in a manner to be specified in the scheme. Out of the fund thus formed, besides meeting working expenses, they will pay compensation to producers where necessary to ensure the equitable working of the scheme, and will from time to time distribute any surplus among the producers in proportion to their contributions (Section 7 (1)). They may also lend to any producer a portion of the amount they estimate that he will receive from the sale of his produce (Section 7 (2)).

A board in Scotland may borrow money on the security of agricultural produce belonging to it and in its possession, as an agricultural society may under Part II of the Agricultural Credits (Scotland) Act, 1929 (Section 19 (1)). The power of borrowing conferred on a board in England is wider.

State Assistance.—It is also, however, provided that loans may be made to boards from public funds. An Agricultural Marketing Fund is to be set up for England and one for Scotland, the respective amounts being £500,000 and £125,000 (Section 11 (1) and (2)). From these Funds loans of two kinds may be made—(*a*) for a period of not more than two years, but renewable on certain conditions, (*b*) for a longer period. The short-term loan is intended to provide for expenses connected with the initial working of a scheme and for any additional services that the board may subsequently undertake. The initial loan may be made free of interest (Section 13 (2)). The long-term loan is intended for working capital. The total amount that may be outstanding at any time in long-term loans is £100,000 in the case of the English Fund and £50,000 in that of the Scottish (Section 14). It will be seen that only one-fifth of the English Fund may be so used, while in Scotland the proportion is two-fifths. This difference is due to the consideration that on the one hand it will probably be less costly to initiate schemes in Scotland, and that on the other hand the schemes will probably be of the "pool" type, which will require larger long-term loans than schemes of the "regulating" type.

The Treasury may at their discretion direct that the whole or any part of a loan that appears to be irrecoverable shall be written off, and in that case an amount equal to the amount written off will be paid into the Fund to maintain its level (Section 11 (5)). As has been already mentioned, if a scheme is rejected on the poll, the liabilities incurred by the board up to that point will be written off the loan made to the board for initial expenses.

The Scottish Fund will be administered by the Department of Agriculture, which will make and renew loans on the recommendation of an Agricultural Marketing Facilities Committee set up for the purpose (Section 12); a loan for the purpose of meeting the expenses of the initial poll may however be made without such recommendation (Section 13 (11)). Similar Committees will be set up for England and if necessary for Great Britain.

Consumers' Committees and Committees of Investigation.—In order to safeguard the interests of consumers, Consumers' Committees are to be set up for England, Scotland and (if necessary) Great Britain, to consider and report to the Minister on the effect of any scheme on consumers, and on any complaints that may be made to them by consumers. Each Committee is to consist of not less than seven members, one representing the co-operative consumers' movement (Section 9 (1) and (2)). Any report made by a Consumers' Committee and any complaint made to the Minister that cannot be dealt with by that Committee are to be investigated by a Committee of Investigation, consisting of five members. Either Committee may call on the board concerned to produce its accounts, &c. If the Committee of Investigation reports adversely the Minister may direct the board to modify the scheme, or may himself modify or revoke it. Each of these steps requires Parliamentary approval, which in the case of revocation must be expressed positively by resolution of each House (Section 9 (3) to (5)).

Agricultural Marketing Reorganisation Commissions.—In the preceding paragraphs three bodies are mentioned that are to be set up to advise the Minister and the Department in various ways as to the working of schemes under the Act. A fourth was mentioned earlier—the Agricultural Marketing Reorganisation Commission, which may be appointed to deal either with one product or with more in England, Scotland or Great Britain (Section 15 (1)). Each Commission is to consist of five members (Section 15 (3)). Its first duty is, as already stated, to frame a scheme for the Minister to bring to the notice of the producers of the product in question.

While the responsibility for submitting a scheme rests with the producers, it is recognised that a large and unorganised body of producers may find it difficult to frame a scheme, and will be glad to have one placed before them ready-made. A Reorganisation Commission has a wide field of investigation and is expected to explore the ground thoroughly. It is entrusted with considerable powers of inquiry into the existing methods of marketing produce, and may with Parliamentary sanction be clothed with the powers of a Tribunal of Inquiry under the Act of 1921 (Section 15 (5)). These powers may however be exercised only in relation to " the place of origin, use, channels of distribution, or distribution of any agricultural product," or to the quantity produced or sold. This careful definition was inserted in order to exclude any power of inquiry into the financial transactions of any individual or firm from whom the Commission may take evidence.

A Commission may also investigate the working of any scheme, and particularly (*a*) the extent to which its operation can be furthered by co-operation between the board and other persons, (*b*) the extent to which its operations are hampered by the inadequacy of facilities for manufacture and distribution (Section 15 (2)).

The Scottish application section contains a provision that instead of appointing a Commission the Secretary of State may vest its powers in an existing agricultural organisation or in its governing body (Section 19 (7)). The organisation in question is the Scottish Agricultural Organisation Society, which has for more than twenty years been engaged in promoting agricultural co-operation, and has recently taken a large part in forming the Scottish Milk Agency, the Scottish Wool Growers, and other large scale trading bodies. It would be an unnecessary duplication to appoint another body to do work of the same kind. In its present form, however, the Executive Committee of the Society is too large to take the place of a Commission, and further consideration will have to be given to the carrying out of this part of the Act.

Miscellaneous.—All the expenses of the various committees and commissions, including the remuneration, if any, of their members, will be met from public funds (Section 16).

The disclosure by any person of information obtained by him in connection with a poll or with the operations of a board or of any of the committees and commissions is punishable by severe penalties.

Detailed provision for the amendment and revocation of schemes is made in Part II of the First Schedule, and for the incorporation, registration and winding-up of boards in the Second Schedule. Attention may be drawn to paragraphs 7 and 8 of the latter, which relate to the financial liability of a registered producer in the event of a board's being wound up.

References occur throughout the Act to a " substitutional scheme," which is one that takes the place of one or more existing schemes. The procedure involved in putting a scheme of this kind into force differs in some respects from that involved in launching an entirely new scheme.

Among the definitions in Section 18 that of " regulated product " is of interest owing to the fact that here alone does the Act specifically state that a scheme relates only to a product so far as it is produced within the area to which the scheme applies.

Some difficulty was found in determining who is the " producer " of any kind of live stock; the definition finally adopted is in Section 18 (3) :—" Every person whose business it is to keep live stock of that kind for the purpose of breeding from it or selling it in an improved condition."

Application to Scotland.—Some of the special provisions applying only to Scotland have already been mentioned. More important than these is the power conferred on the Secretary of State of approving a scheme that makes the governing body of an existing agricultural society [1] a board for the purposes of a scheme if he is satisfied (*a*) that the members of the society are substantially representative of the producers of the product concerned in the area covered by the scheme, (*b*) that the society has made with each of its members who is a producer of the product a contract binding him not to sell the product produced by him otherwise than through the agency or with the written consent of the society (Section 19 (3)). In such a case the producers who are not members of the society are to have representatives on the governing body for the purposes of the scheme, and the fund controlled by the governing body as a board is to be kept separate from the funds controlled by it as the governing body of the society (Section 19 (4)). This provision was inserted in view of the existence in Scotland of several large-scale societies of this kind.

It is also enacted that a contract by a member of an agricultural society binding him not to sell a product produced by him otherwise than through the agency or with the written consent of the society or of its governing body shall not be held to be in restraint of trade or to be illegal on that ground (Section 19(5)). This applies to all agricultural societies, and not merely to societies the governing bodies of which become boards under the Act. Such contracts have in fact been declared to be legal, but it was thought advisable to give them statutory sanction.

There is a further provision that a member of an agricultural society may create a charge in favour of the society over any product that he is under contract to sell through its agency as security for sums advanced to him in anticipation of the payment of sums received from the sale of the product.

Most of the provisions specially applying to Scotland are based on the recommendations of the Committee on Agricultural Co-operation, to which reference has already been made. This does not however apply to Section 19 (6), which provides that no benefit that may accrue to a landholder or a statutory small tenant or other occupier of an agricultural holding from the operation of the Act shall be taken into account by the Land Court or by an arbiter in fixing rents under their respective powers.

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[1] An agricultural society is defined as " a society or company registered under the Industrial and Provident Societies Acts, 1893 to 1928, or under the Companies Act, 1929, having for its object or one of its objects the sale on behalf of its members of any agricultural product."

Copies of the Act may be obtained from H.M. Stationery Office, 120 George Street, Edinburgh, either directly or through any bookseller, price 6*d.*, or by post 7*d.*

A fuller exposition of the Act, with a chapter on its application to Scotland, is given in a Report issued by the Ministry of Agriculture and Fisheries (Economic Series No. 33), which may be obtained as above, price 6*d.*, or by post 8*d.*

RECENT LAND ACTS.

The Agricultural Land (Utilisation) Act, 1931; *and The Small Landholders and Agricultural Holdings (Scotland) Act,* 1931.

DURING the Parliamentary Session the Government introduced into Parliament a series of important agricultural measures among which were the Agricultural Land (Utilisation) Bill and the Small Landholders and Agricultural Holdings (Scotland) Bill. Both measures received the Royal Assent on 31st July 1931.

Although the Government have since decided that they are unable to ask Parliament to sanction the provision of funds either this year or next year for the purposes of the Agricultural Land (Utilisation) Act, it may be of interest to summarise briefly the main provisions of the Statute.

The Act is in three parts, dealing respectively with the promotion of the better utilisation of land, small holdings and allotments, and finance.

Under Part I the Department are empowered to acquire by agreement land for use as demonstration farms and for reconditioning. The provisions of the Act dealing with reconditioning will permit the Department (1) to acquire land by agreement where they consider that the execution of reclamation, drainage or other works is necessary for its satisfactory and economical use for agricultural purposes; and (2) to require the owner of neglected land to execute any necessary works of maintenance, and in the event of his failure to do so to acquire the land compulsorily for the purpose.

Part II of the Act deals with the provision of small holdings and allotments. With regard to small holdings the Department were already empowered to settle applicants with sufficient experience and capital, but under the new Act it is designed that they should be enabled to offer holdings to certain classes of applicants not so qualified, viz.: (a) unemployed persons, (b) agricultural workers, and (c) members or ex-members of His Majesty's Forces who have had suitable courses of training in agriculture. Suitable applicants selected from these classes would become eligible to receive maintenance allowances for a limited period and loans for stock, feeding stuffs, fruit trees, &c.

As regards allotments, the Act confers additional powers on the Department for directly or indirectly providing allotments for unemployed or partly-unemployed persons, and for defraying losses incurred by local authorities or allotment societies to enable them to supply seeds, fertilisers and equipment to persons who are unemployed or not in full-time employment and for whom allotments are made available.

The Small Landholders and Agricultural Holdings (Scotland) Act, 1931.—This Act amends the Small Landholders (Scotland) Acts, 1886-1919, and the Agricultural Holdings (Scotland) Act of 1923. It is in two main parts, Part I dealing with the law relating to small holdings, and Part II amending the law with regard to other agricultural holdings.

Under Part I right of compensation is secured to an incoming holder who pays the outgoing holder or the landlord for permanent improvements on the holding, and the Department may assist the incoming holder to make such payments.

Additional facilities are accorded to the Department for obtaining necessary information from landlords and tenants regarding land proposed to be taken for small holdings.

Power is given to the Land Court to remove holders for breach of statutory conditions of landholders' tenure.

The law relating to landholders' holdings which fall vacant (Section 17 of the Act of 1911) is amended, the new Act providing simplified machinery for retaining such holdings under landholders' tenure in cases where the Department think it proper to do so.

The occupation for personal residence by a landlord having no other landed estate is not now to be regarded by the Land Court as a reasonable purpose for resumption, and the provision in Section 19 of the 1911 Act by which feuing was to be deemed a reasonable purpose for resumption is repealed.

Compensation in respect of permanent improvements to which the landholder will be entitled when he leaves may now be assessed by the Land Court prior to the termination of the landholder's occupation. This will facilitate the re-letting of holdings.

Every statutory small tenant in existence at the passing of the Act is given the option of becoming a landholder, unless the landlord undertakes to give the tenant the same rights to compensation for permanent improvements as if he were a landholder, in which case the tenant will be deemed to be a landholder as regards those rights but in no other respects.

The restriction imposed by the 1911 Act which limited assistance by the Department for building equipment of holdings to loans is removed.

In future a landholder's outgoing term must be the same as his term of entry unless otherwise agreed.

The rights of landholders to protect their holdings against damage by game are extended.

Other Sections of Part I of the Act provide for the termination of the rights of holders who fail to occupy their holdings; power to the Department to grant to existing holders loans for new buildings whether in replacement of existing buildings or not; amendment of procedure for the enlargement of holdings; definition of the expression " predecessors in the same family " in order to secure the right of a holder and his successors to compensation for improvements executed by them; making of records of holdings; repeal of the provisions of the 1886 Act whereby a landholder or cottar is precluded from obtaining compensation for improvements which he was bound under written agreement to execute; payment of compensation for disturbance to a statutory small tenant whose holding is resumed in whole or in part; increasing the facilities of the Department for carrying out schemes of land settlement by extending the time during which the necessary statutory procedure may be completed, and by providing that claims for compensation will be lodged within a reasonable time; amendment of the law relating to obligations of holders under the Public Health (Scotland) Act of 1897; loss of right to the renewal of tenancy of a statutory small tenant where a notice to quit has been given by him; facilities for carrying out settlement schemes on grazing subjects; permitting landholder's tenure within the royalty area of burghs; and protection to landholders against agreements purporting to contract out of the Landholders Acts.

Part II of the Act is intended chiefly to afford increased encouragement to tenants to carry out permanent improvements which will enhance the productivity of their holdings and for which compensation will be payable at outgo. For this purpose some improvements hitherto included in Part I of the first Schedule (improvements to which consent of landlord is required) have been transferred to Part II of the Schedule (improvements in respect of which notice to landlord is required). The introduction of electrical equipment has also been included in the Schedule for the first time. Provision has been made for appeal to the Department in those cases where landlord and tenant are at variance on the question of carrying out an improvement comprised in Part II of the Schedule; and Section 3 of the 1923 Act has been amended so as to allow a tenant a period of as much as three months within which, after giving notice, he may start to make one of those improvements.

Important amendments in the law are introduced in regard to matters referred to arbitration, and for the improvement of the machinery of arbitration.

Other amendments contained in Part II provide for payment of compensation for temporary pasture subject to certain deductions; rendering invalid a claim by a landlord for deterioration of a holding unless a record of the condition of the holding has been made; repeal of the provision in the 1923 Act requiring a tenant to give, one month before the end of his tenancy, notice of his intention to make a claim for compensation for disturbance; safeguarding a tenant's rights to compensation where a landlord in pursuance of his rights under a lease resumes land on a holding without giving notice to the tenant; and requiring a landlord to expend sums recovered under a fire insurance policy on the restoration of the damaged or destroyed buildings in those cases where the tenant has been liable to pay the whole or part of the insurance premium.

Part I of the Act forms one of the series of the Landholders Acts, which are now described as The Small Landholders (Scotland) Acts, 1886 to 1931; and the Agricultural Holdings (Scotland) Act, 1923, and Part II of the new Act are cited as the Agricultural Holdings (Scotland) Acts, 1923 and 1931.

Improvement of Live Stock (Licensing of Bulls) Act, 1931.

AMONG the measures affecting agriculture to which the Royal Assent was given on July 31st is the Improvement of Live Stock (Licensing of Bulls) Act, 1931, the object of which is to improve the quality of British commercial cattle stock by the elimination of inferior bulls.

In view of the increasing competition from other countries, which have graded up their stocks to such an extent that they are able to send beef of excellent quality to this country, it is a matter of urgent concern to raise the general standard in Britain so that home-produced beef may not only retain but improve its position in the home market.

In Northern Ireland and the Irish Free State, where similar legislation has been in force for a number of years, a steady improvement is reported in the general standard of Irish cattle, an improvement which is reflected in the considerably increased number of premium bulls now available in Ireland and in the quality of store cattle exported therefrom.

The main features of the new Act, the major provisions of which come into force in Scotland on the " appointed day," which is to be " not earlier than one year after the passing of the Act," provide for :—

(1) The licensing of bulls which after the " appointed day " attain an age to be prescribed, and the prohibition, enforceable by penalties, of the use of unlicensed bulls;

(2) The granting of permits to owners to keep bulls for limited periods for purposes other than breeding;

(3) The slaughter or castration of bulls of the prescribed age and in respect of which a licence or permit has not been granted;

(4) The prohibition of entry, except for slaughter, of bulls which have been rejected in Ireland. (This provision comes into force as from the date of the passing of the Act.)

A licence granted by the Department remains in force during the lifetime of the animal, unless suspended or revoked, or unless the animal has been outside Great Britain for a consecutive period of fourteen days or such longer period as may be allowed. Provision is also made for the transfer of licences when bulls are sold.

A licence may be refused for any bull which appears to the Department to be of defective conformation and likely to beget defective or inferior progeny, or which is permanently affected with any contagious or infectious disease or any other disease rendering it unsuitable for breeding purposes. The Department may revoke a licence if the conditions of the licence are not complied with, or suspend it if the animal is temporarily affected by a disease or defect rendering it unsuitable for breeding purposes. They may also refuse to grant a permit on any grounds which appear to them sufficient.

An owner can appeal against the decision to refuse a licence or to suspend or revoke an existing licence. When such an appeal is lodged the animal requires to be inspected by a referee selected from a panel to be constituted by the Department on the recommendation of such agricultural associations and cattle breeding societies as may be consulted. The fee is returnable if the appeal is successful.

The Department are empowered by regulation to "prescribe" various matters referred to in the Statute, including the age and markings of bulls, the forms of notice, the fee payable on an appeal against the Department's decision, &c. Any regulations so made require to be laid before both Houses of Parliament.

THE following article has been contributed by Mr. A. B. Fowler, B.Sc., of the Hannah Dairy Research Institute :—

Renewal of Old Pasture.

The cultivation of permanent pasture forms an important item in agricultural practice in the south-west of Scotland. Comparative figures, based on the Agricultural Returns for Scotland, June 4th, 1929, illustrate the relative importance of permanent pasture in the south-western and south-eastern areas :—

Percentage of land under :—	South-east of Scotland.	South-west of Scotland.
A. Rotation crops	41·6 per cent.	19·0 per cent.
B. Permanent pasture including hay ...	34·8 ,,	54·2 ,,
C. Rotation grass including hay	23·6 ,,	26·8 ,,

The successful management of permanent grass land involves the continual improvement and rejuvenation of old worn-out pasture. The system of dairy farming as carried out in numerous cheese farms in the south-west of Scotland does not permit of any extensive renewing of old pasture by means of rotation cropping, and it is therefore very important to explore new methods of effecting improvement in existing pastures without recourse to a rotational system.

In 1925 Professor R. G. Stapledon of the Welsh Plant Breeding Station formulated a method [1] for the improvement of very poor pastures. This consisted, in brief, of ploughing up the out-run leys and converting them by immediate re-seeding into high-grade pasture. The seeds mixture was sown almost immediately after ploughing up the old sward, either under a first and only corn crop, or under rape, or without a nurse crop. The writer, on visiting the Welsh Plant Breeding Station, was impressed by the excellence of the swards thus obtained, and has endeavoured to carry out a similar field trial at Kirkhill Farm.

Cultivation.—When the farm of Kirkhill was taken over by the Institute in November 1929 there were about 50 acres of old pasture which had been let to graziers for a number of years. No record could be found of the date when these fields were last broken up, nor of any recent treatment. The fields were ideal for the purpose of the trial, since they corresponded closely with the typical worn-out pasture found in the locality.

One acre of the worst field was ploughed fairly deep in January 1930 and left until April. The surface was thoroughly disked until a fine seed bed was obtained. This was somewhat difficult to procure owing to the presence of fragments of roots from trees which had recently been pulled out by tractor from the centre of the plot, and undoubtedly required more labour than would have been necessary under normal conditions. The following mixture was sown on April 7th :—10 lb. rape, 5 lb. Italian rye grass, 13 lb. perennial rye grass, 8 lb. cocksfoot, 4 lb. timothy and 3 lb. subterranean clover. A full discussion of the use of subterranean clover under British conditions is given in a recent paper by Davies.[2]

Grazing Value.—Growth was very slow to commence owing to the prolonged drought, but following the wet weather in the middle of May the rape came away rapidly, and was eaten off by sheep on June 9th. For this purpose 250 ewes and lambs were allowed to graze on the rape for 48 hours, care being taken not to leave them on long enough to damage the grasses, which were now coming away strongly. The grass was rested, and a fortnight later the Italian rye grass was firmly established. This was eaten off in four days by 150 ewes and lambs. After resting the plot until July 28th, 50 ewes were grazed on it for three weeks, after which it was again rested in order to allow the subterranean clover to re-seed itself. Davies stated in his paper that, under Welsh conditions, late flowering clover produced seedlings which were too weak to withstand winter conditions, while June-sown plots produced plants which were capable of outwintering—providing keep at mid-winter and spring. It was, however, considered that, with the more open winters on the Ayrshire coast, the late seeded clover would survive.

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[1] Stapledon, R. G., *Jour. Ministry of Agriculture*, vol. xxxii, No. 1, pp. 18-24 (April 1925).

[2] Davies, W., *ibid.*, vol. xxxiv, No. 5, pp. 455-467 (August 1927).

By the end of October the appearance of the pasture was excellent, with a splendid distribution of clover throughout the plot. In November and December, and in January 1931, the acre was grazed at intervals by 30 Blackface hoggets. In February three Suffolk tups were put on to graze, but through an oversight they were allowed to remain too long, with the result that the clovers were seriously affected by selective eating. It is possible that (as Davies points out) the disappearance of clovers at this stage may also have been partly due to winter and spring frosts.

The pasture was top-dressed at the end of March 1931 with 1 cwt. of nitro chalk and 2 cwt. of superphosphate, these being some artificial manures which happened to be left over from the previous year. During the third week in April four 7-month-old heifer calves were put out to graze, in order to keep the grasses in check, but they were unable to do so, and two further heifers were added during the second week in May. At this time there was quite an appreciable number of subterranean clover plants showing, while wild white clover, though not sown in the mixture, also started to appear. Even with this added stock, however, the pasture was under-grazed, with the result that at the date of writing (July 1931) the rye grasses have shot, and it will be necessary to mow the stem growth.

Summary of Trial.—A new method of renewing pasture can be considered successful only if (*a*) a good sward is produced in a relatively short time, and (*b*) the feeding value of the produce during the year of sowing is not materially lower than that obtained by other methods of pasture renewal or improvement. From this point of view it is considered that the present trial has been successful in its aims. In the first place an excellent sward was obtained by ploughing and immediate re-seeding. In the second place the experimental plot provided excellent feeding during the year in which it was sown. In the third place the experimental plot showed marked advantage over plots of the original pasture which had been treated with various types of artificial manures; the old pasture, although it was rested all the winter, did not come away in the spring, and stock could be turned out on it only after the first week in May.

The results of the present field trial—though admittedly preliminary—justify a more extensive investigation of the new method under typical Scottish conditions. In this connection it should be noted that the seed mixture used at the Institute was not intended for permanent pasture. The ultimate object to be attained is, however, the development of a rapid and economical means of replacing old worn-out pasture with new *permanent* pasture. For this purpose the writer suggests that the following seed mixture would be found suitable on medium soils :—5 lb. Italian rye grass, 6 lb. perennial rye grass, 8 lb. cocksfoot, 4 lb. timothy, 5 lb. meadow fescue, 4 lb. meadow foxtail, 1 lb. rough-stalked meadow grass, 1 lb. broad-leaved clover, ½ lb. late flowering clover and 1 lb. wild white clover. It is most important to ensure that only indigenous strains of these grasses are sown.

Craibstone.

Notes from Agricultural Colleges.

Grasses and Clovers, 1931.—The hay crop of 1931 was generally good, there being a fine mixture of grasses and clovers. As in the previous year the late flowering red was much more prominent than broad leaved, while in a good many places there was much more alsike present than was usually the case in other seasons. This was especially true where late flowering was not so plentiful.

The following results were obtained this year with trials of red clover from different sources. The seed mixture was the same in each case, namely, 13 lb. perennial ryegrass, 8 lb. cocksfoot, 4 lb. timothy, ½ lb. wild white clover, and 3 lb. per acre of red clover were included in turn.

	Per acre.		
	Grass. cwt.	*Clover.* cwt.	*Total.* cwt.
Late Flowering.			
American Mammoth ...	35·5	15·8	51·3
English	26·8	34·2	61·0
Montgomery	18·6	50·2	68·8
Russian	32·8	6·5	39·3
Swedish	23·5	43·7	67·2
Polish	30·5	7·2	37·7
Broad Leaved.			
Chilian	33·5	4·6	38·1
English	28·0	23·8	51·8
French	32·1	12·5	44·6
New Zealand	27·7	22·7	50·4

These results are much the same as in previous years, and indicate that the only countries outwith England and Wales from which it is safe to get red clover seed for this part of the country are Sweden and New Zealand.

As we are so far from the seed producing areas of England it is often difficult to get the true history of samples. Two samples of English saved seed were got, however, which were known to have been the produce of Chilian and Polish seed respectively.

When these were sown both in rows alone and in the field as part of a seed mixture they showed quite distinctly that they were no better than seeds got direct from Chili and Poland. Farmers in England who intend to sell red clover seeds to farmers in the North of Scotland should sow only native or acclimatised seed.

A large number of small plots was sown with different samples of late flowering red in order to see if they were genuine. Out of 16 samples of English, three were somewhat mixed while two were broad leaved. Three out of 31 samples of Montgomery were mixed with broad leaved; one was entirely broad leaved while the others were genuine. Five Swedish samples were all late flowering and were later than late flowerings from all other sources. Two (out of five) samples of American Mammoth were broad leaved, and the genuine samples were distinctly earlier than any of the other late flowering reds except Polish, which was even earlier than broad leaved, and should not be included among the late flowering types.

Russian late flowering reds appear to be a mystery. While they are mostly all distinctly late in flowering, in this part of the country they have always done very poorly, although further south they appear to do quite well.

From these trials, carried out now for a good many years, it is concluded that the most satisfactory seed of the broad leaved red for the North of Scotland would be a blend of three or four different English samples. So far as late flowering is concerned the best results are likely to be obtained from a blend of equal proportions of English, Montgomery and Swedish.

Nowadays a larger proportion of samples of wild white clover is grown than in former years and, while some of these give almost as good results as seed saved from old pasture, other samples are distinctly inferior.

About 150 samples were tested chemically by the picric acid method, and in a good many cases, where there was a larger proportion of large seeds in a sample than we look for in good true samples, these large seeds gave a weaker reaction than the small seeds in the same sample. Further, when sown out separately in rows the plants produced from the large seeds had larger leaves and flowered earlier and more freely than the plants produced from the small seeds. In some cases the plants of the former were much less vigorous than of the latter and many died out during the second year.

Samples were included from many different counties of England. Generally, those from Kent were good but a few were inferior. Samples obtained from Buckingham, Essex, Suffolk, Hampshire, Northamptonshire, Norfolk and Gloucester also produced vigorous plants. Each sample must be judged on its merits. When sown in the field as part of a seed mixture poor samples were always more than correspondingly poorer.

Many samples of New Zealand wild white gave interesting results. As in the case of English samples the large and small seeds were sown separately. The plants from the former had much larger leaves and flowered earlier than the latter. In previous trials it was noted that there were two types among New Zealand wild whites, one with large and the other with small leaves, the latter being less vigorous. It would appear as if both types were present in many samples, but the smaller plants would be masked by the larger, more vigorous ones.

In the field while some samples were fairly good in second year's grass, they were much poorer during the third year. Many other samples were poor even during the second year. The best samples were those that gave a strong chemical reaction.

An American sample with a high reputation did very poorly, like all samples previously tried from that country. Similarly, white clover taken out of a mixture of alsike and white from America lacked vigour.

The adverse effect of perennial ryegrass on cocksfoot and timothy was again well illustrated in an experiment where several plots were seeded with 8 lb. cocksfoot, 4 lb. timothy and 5 lb. clovers. Different amounts of perennial ryegrass were included in turn in the plots. As in previous trials, while there was comparatively little difference in the weight of hay obtained from the different plots, there was a considerable difference in the amount of cocksfoot and timothy present.

The following results obtained from two extreme and an intermediate quantity of perennial ryegrass will serve to show this :—

Perennial ryegrass sown:	*6½ lb.*	*19½ lb.*	*39 lb. per acre.*
Cocksfoot in hay ...	4·3	1·6	0·3 cwt. per acre.
Timothy in hay ...	7·6	3·5	0·6 do.

In another plot no perennial ryegrass at all was sown, but only 12 lb. cocksfoot and 6 lb. timothy along with 5 lb. clovers, a total seeding of 23 lb. per acre. In previous years this mixture produced rather a smaller hay crop, but this year it was quite as good as where perennial ryegrass was included. Further, it had the distinct advantage that it stood well up, while all the plots alongside were lying to some extent. When separated out it was found that there were 9 cwt. cocksfoot and as much as 30 cwt. per acre of timothy in the hay, showing very markedly that timothy is very adversely affected even by such a small quantity as 6½ lb. perennial ryegrass per acre. When perennial ryegrass is included in a mixture and when equal numbers of the seeds of cocksfoot and timothy (that is, usually double the number of pounds of cocksfoot as of timothy) are also included, there is generally about twice as much timothy in the hay as of cocksfoot, but in the above example, where there was no perennial ryegrass, there was about four times as much, a remarkable result considering the amount of seeds sown.

Many visitors who saw the aftermath of these mixtures were impressed by the difference in the appearance and composition.

Part of each of the four plots was cut just before they were eaten by the cattle, and the following are the amounts of cocksfoot and timothy in them :—

Perennial ryegrass sown:	0	6½ *lb.*	19½ *lb.*	39 *lb. per acre.*
Cocksfoot ...	5·8	9·0	5·9	1·4 cwt. per acre.
Timothy ...	8·9	1·5	0·8	0·3 do.

In addition to showing very markedly the adverse effect of the large quantity of perennial ryegrass, these figures show that cocksfoot is much more prominent in the aftermath than timothy except in the no perennial ryegrass plot, where it more than held its own. These results are very suggestive.

Over 20 samples of the leafy late flowering type of perennial ryegrass sold under such names as evergreen, indigenous or wild were sown. In order to see more clearly the characteristics of each plant a number of plants of each sample was planted out separately. In most samples there was a difference among individual plants, some having a large proportion of leaf, while others had a large proportion of stalk, leaves being much less prominent.

About one-third of the samples were mainly of the stalky type with very few leafy plants. Several samples were called Ayrshire Evergreen. These were in all probability once grown evergreen. There was again, however, a considerable difference among them, some being little better than ordinary perennial ryegrass.

An examination of the seeds showed that in all the good leafy samples they were much smaller than in those where the stalky type predominate. In typical samples the weights per 1000 seeds were as follows :—

Ordinary perennial ryegrass	2·89 grams.
Late flowering do.	1·78 ,,

When equal quantities (13 lb.) of Ayrshire and late flowering were used in turn in the same seed mixture (8 lb. cocksfoot and 4 lb. timothy and 5 lb. clovers), the pasture showed much more perennial ryegrass with the late flowering, but there was a reduction of the other grasses and of white clover.

In another trial the same mixture was used, but with the following four quantities of the late flowering perennial ryegrass —6, 9, 12, 18 lb. During the whole of the grazing season the first two plots were distinctly better than the last two, and the other grasses and white clover were more prominent and showed much more growth.

In another set of plots 8 lb. of several different samples of cocksfoot were included. Danish and German started growth earliest in the season and were well eaten down by the cattle. Later on, however, they came into ear and the produce was small. New Zealand, an English and a home selection, which were all of the leafy late flowering type, stocked out and were very much thicker all the season and were well eaten down. Swedish was intermediate.

These trials gave no indication, however, as to the relative feeding value of the early and late flowering types of these grasses.

Several feeding trials are in progress. The results so far indicate that there may be a slight live weight increase if the proper proportions were ascertained. It must be kept in mind that in such a trial the comparison is not between these types of grass, but in seed mixtures containing them.

The effect of the manures applied to the previous grain crop on the amount of red clover in the subsequent hay crop was very marked this year.

Last year in a field of Victory oats the following complete manure was used :—1 cwt. sulphate of ammonia, 1½ cwt. superphosphate, 2½ cwt. ground mineral phosphate, and 1 cwt. muriate of potash. In other plots the nitrogen, phosphates and potash were omitted in turn. No manure was applied direct to the hay crop.

The following results were obtained :—

	Per acre.		
	Grass. cwt.	*Clover.* cwt.	*Total.* cwt.
After complete manure ...	15·6	23·5	39·1
No nitrogen	14·4	33·5	47·9
No phosphate	17·1	13·9	31·0
No potash	17·4	11·5	28·9

The effect on the amount of red clover in the aftermath was equally marked.

Similar plots which were in hay last year are now in pasture, and the effect of the nitrogen on the white clover was very interesting. In the complete manure plot with sulphate of ammonia the wild white covered the ground much earlier in the season than in the no nitrogen plot. This was evidently due to the adverse influence of the larger amount of red clover present in both hay and aftermath.

Boghall.

Cereals.—The wet and late season has had the effect of subjecting the standing capacity of the cereal varieties to a severe test, and of showing up in a marked way the differences in earliness of ripening. In the following tables the oat and barley varieties growing on the farm are arranged in order of ripeness and stiffness of straw. Harvest has not yet commenced (September 14th), but the earliest sorts will be ready to cut in a day or two.

Oats.

Earliness.	*Standing Capacity.*
1. Yielder.	1. Elder.
2. Pure Line Potato.	2. Pure Line Potato.
3. Marvellous.	3. Marvellous. Yielder.
4. Peragis.	4. Peragis. Eagle.
5. Ascot. Diamond.	

Earliness.

6. Victory.
Star.
Progress.
Eagle.
Castleton Potato.
7. Silver.
8. Golden Rain II.
9. Elder.

Standing Capacity.

5. Silver.
Ascot.
6. Star.
Progress.
7. Diamond.
8. Victory.
9. Golden Rain II.
Castleton Potato.

The difference in the time of ripening between Golden Rain II and Yielder is estimated to be about 14 days, the other varieties, with the exception of Elder, being intermediate. Elder is obviously too late for Boghall, where the cultivated land is at 600 feet elevation.

With regard to standing capacity, Elder and Pure Line Potato are standing perfectly and could be cut round about with a binder. At the other extreme, Golden Rain II and Castleton Potato are very seriously lodged and will present great difficulty at harvest. The intermediate varieties are more or less swung or lodged in parts but may be cut one way with the binder.

Barley.

Earliness.

1. Plumage No. 63.
2. Plumage.
3. Hallwick.
4. Plumage Archer.
5. Triumphant.

Standing Capacity.

1. Triumphant.
2. Plumage No. 63.
3. Plumage Archer.
4. Plumage.
Hallwick.

There appears to be rather more than a week's difference in the time of ripening of the barleys, but none is too late for Boghall conditions. Triumphant is standing excellently and could be cut round about. Plumage No. 63 is swung but could be cut one way. The remaining varieties are very badly lodged.

Wheat Trial.—A trial has been conducted this season with Victor wheat, using seed from two Lothian sources in comparison with seed from Norfolk. The three lots were sown, according to the official germination test, so as to provide the same number of germinating seeds per acre in each case. Throughout the season the crop grown from Norfolk seed has been much the most vigorous, thus demonstrating that the germination test alone is an insufficient guide to the quality of a seed sample. The final results of this trial will be available when harvesting and threshing have been completed.

Turnips.—Work is going on with a view to selecting turnip varieties that are resistant to finger-and-toe disease. For this purpose an area of ground was thoroughly inoculated with the fungus. Half the area was then limed, and the varieties under trial were grown partly on the limed and partly on the unlimed portions. At present the roots grown on the limed area are a vigorous and healthy crop showing practically no sign of disease. On the unlimed part the most resistant variety by far is The

Bruce, with the variety Victor Achilles a good second. Varieties of low disease resistance are a complete failure on the unlimed plot.

Hay.—In an experiment on manuring hay the following results have been obtained :—

1. Phosphates and potash only gave	2 tons	2 cwt.	0 qr.	per acre.
2. As in plot 1 plus 1 cwt. nitrate of soda per acre gave	2 ,,	9 ,,	2 ,,	,,
3. As in plot 1 plus 2 cwt. nitrate of soda per acre gave	3 ,,	2 ,,	1 ,,	,,
4. As in plot 3 but nitrate of soda given in two dressings gave	3 ,,	0 ,,	1 ,,	,,

While great accuracy cannot be obtained from single plot tests, the trial nevertheless indicates that even in a period of low prices the full manuring with nitrate of soda gives profitable results. It is probable that there is no significant difference between plots 3 and 4.

Pigs.—A feeding trial with pigs has shown that ground wheat may be used satisfactorily as a substitute for wheat offals, thus offering a further outlet for wheat when market prices justify its use for feeding purposes.

The ration employed for pigs of 10 weeks and upwards consisted of 50 per cent. barley meal, 30 per cent. ground wheat, 10 per cent. bran and 10 per cent. meat meal, with the addition of two parts of mineral mixture [1] per 100. The live-weight increase in the case of animals on this ration equalled that obtained from pigs of equal age and quality fed on the more usual type of ration containing sharps in place of wheat and bran.

At present a trial is going on to ascertain if the proportion of wheat can be increased to 50 per cent. of the ration.

Reviews.

Beasts and Birds as Farm Pests. James Ritchie, M.A., D.Sc., F.R.S.E. Oliver & Boyd. Price 12*s.* 6*d.*—Many readers of this Journal will welcome the publication in book form of the series of articles on Farm Pests contributed to its pages by Professor Ritchie. The book is intended primarily for the information of the practical agriculturist, who will find in it authoritative guidance in assessing the importance of the various pests and in dealing with them in the most effective way. To teachers and students in agricultural colleges and farm institutes it should also prove of great value, as it applies a want not adequately met by any other single volume. Further, it should fulfil the hope modestly expressed by the author in his preface that " here the County Councils of Great Britain will obtain help in deciding the difficult problems of the protection or otherwise of birds, which are laid upon their shoulders by the Wild Birds Protection Acts."

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[1] Two parts sterilised steamed bone flour, one part finely ground limestone, and one part common salt.

Some textual alterations, bringing the facts up-to-date, have been made on the original articles, while many illustrations have been added; the copious and excellent illustrations are indeed an important feature of the book and should make identification of the pests comparatively easy. The volume, which has a full index, has been handsomely produced by the publishers.

The Department of Agriculture for Scotland, having been sponsors for this work in its first form, venture to hope that in its new and most convenient shape it will meet with general acceptance and will serve as widely as possible the scientific and economic purposes for which it was designed.

"*Agriculture and Live Stock in India*" ; "*The Indian Journal of Agricultural Science*" ; "*The Indian Journal of Veterinary Science.*"—The Imperial Council of Agricultural Research in India have recently reorganised the issue of publications dealing with the science and practice of agriculture. The three journals named above are intended to cover most of the ground, but occasion is to be taken when necessary to bring out special monographs when scientific material is available for publication requiring or deserving separate treatment.

The first-named journal is to be of general interest and popular character, and will deal with agricultural economics, field and garden crops, insect pests, fungoid diseases, economic cultivation, irrigation, climatic conditions, implements and machinery.

The other two are technical and scientific in character and will be the medium of communication for scientific workers in agriculture in different parts of India. They will contain reports and accounts of work done at the various research centres, as well as reprints of papers published elsewhere and abstracts of papers dealing with subjects bearing on Indian agriculture.

To illustrate the scope and character of the journals a brief note of the contents of their first numbers is appended.

In the January issue of *Agriculture and Live Stock* there is a report on Tractor Trials in Burma, where a favourable comparison is made on tractor cultivation of rice fields as against the traditional method of employing bullocks. The contributor of an article on Cattle Breeding makes a strong plea for permanent control of breeding policy, and for an effort to interest wealthy landowners in schemes of stock improvement. Besides other original contributions on Indian topics there are articles selected from publications appearing in other countries, such as one on the ringing of fruit trees; another on the relation of insects to virus diseases of the potato; and three addresses on agricultural subjects—(*a*) that of Sir F. Keeble on Soils and Fertilisers in South Africa; (*b*) that of Dr. P. J. du Toit on Veterinary Science in Agricultural Development; and (*c*) that of Dr. J. B. Orr on Calcium and Phosphorus Requirements of Farm Animals.

The original articles in the February issue of the *Journal of Agricultural Science* are reports of research work on:—(1) Inheritance of Characters in Indian Linseed; (2) Classification of Types of Barley isolated at Pusa; (3) Root System of Barleys; and (4) Breeding of Rape. A reprint of an American article on Sterility in Rice Hybrids and abstracts of Brazilian papers on plant diseases and pests are included.

The subjects dealt with in the March issue of the *Veterinary Science Journal* include Inoculation of Cattle against Rinderpest; Three-Day Sickness of Cattle; Undulant Fever; Worms and Drugs; Coccidiosis. Papers dealing with animal diseases are abstracted, and a note is given of the publications sent out through the Imperial Bureaux of Animal Nutrition and Animal Genetics.

The form and the style of the journals are attractive, and the illustrations—especially the coloured plates—are remarkably well reproduced.

Agriculture and Live Stock appears in alternate months during the current year, but the Council hope to publish it monthly in 1932. *The Journal of Agricultural Science* is a bi-monthly and the *Journal of Veterinary Science* is a quarterly publication. All three are obtainable from the Office of the High Commissioner for India, India House, Aldwych, London.

Guide to Current Official Statistics, Volume IX.

In modern conditions the statistical treatment and presentation of recorded facts becomes more important with every new development of human activity. In the absence of such a means of concise expression it would be virtually impossible for the student of national or international affairs either to assimilate the extensive information at his disposal, or to convey the results of his enquiries to others. Even to those who realise the unrivalled scope and authority of official statistics, the process of ascertaining which of the many Government publications issued from year to year contain the particular information required is likely to be lengthy and difficult unless some form of detailed index is available.

For this purpose a publication, at once compact and comprehensive, is issued every year under the title of the *Guide to Current Official Statistics*. This contains, in addition to a list of the statistical volumes issued by each Government Department, a systematic index of their contents arranged alphabetically according to subject, with statements of the degree of detail in which the subject is treated and the time and place to which the statistics relate. Directions for using the Guide to the fullest advantage are given in an explanatory introduction; by following these the inquirer is enabled to discover in a few minutes exactly what official statistics relating to his subject are available, and the names and prices of the publications in which they are to be found.

Volume IX of the Guide (price 1*s.* net, post free 1*s.* 5*d.*, pp. 319) has just been issued, and may be obtained direct from the sale offices of H.M. Stationery Office or through any bookseller.

Agricultural Returns for Scotland, 1931.

THE Preliminary Statement of the Agricultural Returns taken in Scotland on 4th June 1931 shows that the total area under crops and grass amounts to 4,638,000 acres, comprising 3,061,000 acres of arable land and 1,577,000 acres under permanent grass. The total acreage is the smallest recorded since 1876, while the area of arable land is the smallest recorded since the Returns were first taken in 1866, being less than in 1930 by 11,000 acres. The area under permanent grass has, however, increased by 8,000 acres, and the diminution in the total area under crops and grass is thus 3,000 acres.

The area under rotation grasses and clover, 1,523,000 acres, has increased by 24,000 acres, while that under other specified crops is 37,100 acres less than in 1930. Reductions in the areas of wheat, barley, oats, turnips and swedes, sugar beet, cabbage and vetches, tares, &c., for fodder amount in all to 43,100 acres, while potatoes have increased by 5,000 acres, and certain minor crops by 1,000 acres.

The outstanding features of the crop returns are the decreases in the three main grain crops, in turnips and swedes and in sugar beet. Oats, barley, and turnips and swedes, all show the smallest acreage on record. The area under oats, 846,000 acres, is 16,000 acres, or 1·9 per cent. less than in 1930. Wheat, with 51,000 acres, reverts to the acreage of 1929 after last year's gain of 3,000 acres, and barley, with 92,000 acres, shows a decrease of 15,000 acres, or 14·0 per cent. The area under turnips and swedes is less than in 1930 by 8,000 acres, or 2·1 per cent., and sugar beet, which last year showed an increase of 1,000 acres over the 1929 figure of 600 acres, has fallen by 500 acres, or 31·3 per cent., to 1,100 acres. Potatoes this year have increased by 5,000 acres over last year's low figure of 123,000 acres. The areas under cabbages and vetches, tares, &c., for fodder each show a decrease of 300 acres. All other crops, including minor crops not separately specified in the accompanying table, have slightly increased in area, except carrots and flax, which show slight reductions.

Of the area under permanent grass, 172,000 acres were cut for hay and 1,405,000 acres were grazed, while of the area under rotation grasses and clover, 417,000 acres were cut for hay and 1,106,000 acres were grazed. The areas under permanent grass for mowing and under rotation grass for mowing were greater than in 1930 by 1,000 and 7,000 acres respectively; the total area cut for hay is thus increased by 8,000 acres.

The live-stock returns show that horses and cattle have decreased in numbers, while sheep and pigs have increased.

Horses used for agricultural purposes are fewer than in 1930 by 2,600, the total, 117,600, being the smallest on record. Unbroken horses of one year and above are fewer by 600, or 4 per cent., but foals show an increase of 200, or 3·9 per cent., on last year's figures. The decrease in horses of all kinds is 2,900, or 1·9 per cent.

The total number of cattle, 1,208,500, is less than last year's figure by 27,500, or 2·2 per cent. This reduction is almost entirely due to decreases in the numbers of feeding cattle, yearlings being down by 10,600 and two-year-olds by 19,700, while cows in milk also showed a slight decrease of 4,400, or 1·3 per cent. Bulls being used for service show an increase of 800, or 4·7 per cent., while cows in calf but not in milk and calves have increased by 3,100 and 3,300 respectively.

The total number of sheep, 7,697,100, shows an increase of 47,600, or 0·6 per cent., as compared with that of the preceding year. All classes have increased; ewes, which number 3,350,700, exceed last year's record figure by 25,500, or 0·8 per cent., while lambs have increased by 16,400 to 3,278,700, which is the largest number on record. Rams and other sheep, one year and above, have increased by 2,800 and 2,900 respectively.

Pigs, which total 154,400, show an increase, in which all classes share, of 11,100, or 7·7 per cent., on last year's figure. Sows and boars have increased by 1,500 and 400 respectively, and other pigs by 9,200.

The returns of labour employed (excluding occupiers of holdings, their wives and domestic servants) at 4th June 1931 are given below together with the relative figures for 1930. The total shows a decrease of over 3,800, in which all classes share. Regular male workers of over 21 are fewer by 1,637, and those under 21 by 478, while women workers show a decrease of 482, and casual workers a total diminution of 1,211.

Regular Workers.	*1931.*	*1930.*
(*a*) Males, 21 years old and over ...	58,400	60,037
(*b*) Males under 21 years old	20,200	20,678
(*c*) Women and Girls	18,100	18,582
Casual Workers.		
(*a*) Males, 21 years old and over ...	5,300	6,023
(*b*) Males under 21 years old	2,900	2,972
(*c*) Women and Girls	6,800	7,216
Total ...	111,700	115,508

The returns of poultry at 4th June 1931 are also given below, together with the relative figures (in brackets) for last year.

	1931.	
Fowls hatched before 1931	2,890,000	(2,766,900)
Fowls hatched this year	3,710,000	(3,550,500)
Ducks hatched before 1931	137,000	(135,500)
Ducks hatched this year	83,000	(90,100)
Geese hatched before 1931	7,400	(7,100)
Geese hatched this year	14,000	(16,000)
Turkeys hatched before 1931	21,000	(18,100)
Turkeys hatched this year	71,000	(79,900)

There is given below a Preliminary Statement, compiled from the returns of varieties of potatoes grown in 1931, of the acreage as at 4th June under the principal varieties, together with the relative figures (in brackets) for each variety as at 4th June 1930. The acreage accounted for here is 110,000, the remaining 18,000 acres not being included in the returns of varieties. The finally revised figures will be published as usual about the end of October.

First Earlies.

	1931.	
Duke of York	1,600	(1,790)
Eclipse	1,200	(950)
Epicure	7,000	(7,700)
Sharpes Express	1,700	(1,710)
Others	900	(970)
Totals	12,400	(13,120)

Second Earlies.

	1931.	
Ally	250	(340)
Arran Comrade	300	(330)
Great Scot	8,500	(10,060)
British Queen	3,600	(3,520)
Royal Kidney	300	(250)
Others	950	(860)
Totals	13,900	(15,360)

Maincrops.

	1931.	
Arran Banner	800	(680)
Arran Consul	700	(620)
Golden Wonder	9,000	(7,990)
Kerr's Pink	44,000	(39,100)
Majestic	6,600	(5,660)
Arran Chief	2,400	(3,040)
King Edward VII	15,400	(15,150)
Others	4,800	(4,710)
Totals	83,700	(76,950)

CROPS AND GRASS.

Distribution.	1931.	1930.	INCREASE.		DECREASE.	
	Acres	*Acres.*	*Acres.*	*Per Cent.*	*Acres.*	*Per Cent.*
TOTAL AREA (excluding WATER)	19,069,007	19,069,007	..	..	..	..
TOTAL ACREAGE under all CROPS and GRASS (*a*)	4,638,000	4,641,000	..	..	3,000	0·06
ARABLE LAND	3,061,000	3,072,000	..	..	11,000	0·4
PERMANENT GRASS (*a*) For Hay ..	172,000	171,000	1,000	0·6	..	..
Not for Hay ..	1,405,000	1,398,000	7,000	0·5	..	..
TOTAL ..	1,577,000	1,569,000	8,000	0·5	..	..
Wheat	51,000	54,000	..	..	3,000	5·6
Barley (including Bere)	92,000	107,000	..	..	15,000	14·0
Oats	846,000	862,000	..	..	16,000	1·9
Mixed Grain	1,400	1,100	300	27·3	..	..
Rye..	3,400	3,100	300	9·7	..	..
Beans (to be harvested as Corn)	3,400	3,300	100	3·0	..	..
Peas	450	400	50	12·5	..	..
Potatoes	128,000	123,000	5,000	4·1	..	..
Turnips and Swedes	365,000	373,000	..	..	8,000	2·1
Mangolds	1,250	1,200	50	4·2	..	..
Sugar Beet	1,100	1,600	..	..	500	31·3
Cabbage	4,400	4,700	..	..	300	6·4
Rape	10,700	10,600	100	0·9	..	..
Vetches, Tares, Beans, Peas, Mashlum, etc., for Fodder	10,400	10,700	..	..	300	2·8
Small Fruit	8,300	8,200	100	1·2	..	..
RYE-GRASS and other ROTATION GRASSES and CLOVER For Hay	417,000	410,000	7,000	1·7	..	..
Not for Hay ..	1,106,000	1,089,000	17,000	1·6	..	..
TOTAL	1,523,000	1,499,000	24,000	1·6	..	..
OTHER CROPS	4,200	3,600	600	16·7	..	..
BARE FALLOW	7,000	5,500	1,500	27·3	..	..

LIVE STOCK.

	No.	*No.*	*No.*	*Per Cent.*	*No.*	*Per Cent.*
Horses used for Agricultural purposes (including Mares for Breeding)	117,600	120,200	..	..	2,600	2·2
Unbroken Horses (including Stallions). One year and above ..	14,500	15,100	..	..	600	4·0
Under one year ..	5,300	5,100	200	3·9	..	..
TOTAL	137,400	140,400	..	..	3,000	2·1
Other Horses	16,000	15,900	100	0·6	..	..
TOTAL OF HORSES	153,400	156,300	..	..	2,900	1·9
Cows in Milk	346,400	350,800	..	..	4,400	1·3
Cows in Calf, but not in Milk..	50,000	46,900	3,100	6·6	..	..
Heifers in Calf	55,400	55,400	..	..	..	..
Bulls being used for Service	17,900	17,100	800	4·7	..	..
Other Cattle :—Two years and above ..	197,100	216,800	..	..	19,700	9·1
,, ,, One year and under two ..	294,000	304,600	..	..	10,600	3·5
,, ,, Under one year	247,700	244,400	3,300	1·4	..	..
TOTAL OF CATTLE	1,208,500	1,236,000	..	..	27,500	2·2
Ewes kept for Breeding	3,350,700	3,325,000	25,500	0·8	..	..
Rams to be used for Service in 1931	95,100	92,300	2,800	3·0	..	..
Other Sheep :—One year and above	972,600	969,700	2,900	0·3	..	..
,, ,, Under one year	3,278,700	3,262,300	16,400	0·5	..	..
TOTAL OF SHEEP	7,697,100	7,649,500	47,600	0·6	..	..
Sows kept for Breeding	19,400	17,900	1,500	8·4	..	..
Boars being used for Service	2,200	1,800	400	22·2	..	..
Other Pigs	132,800	123,600	9,200	7·4	..	..
TOTAL OF PIGS	154,400	143,300	11,100	7·7	..	..

(*a*) Excluding Mountain and Heath Land used for grazing.

Agricultural Conditions.

In most parts of the country the weather during June was cold and wet, particularly during the first two weeks. Part of the sowing of turnips was in consequence carried out later than usual and much of the work was done under unfavourable conditions. Throughout practically the whole country the month of July was sunless while heavy rain was frequent, and the temperature was generally low for the time of the year. Seasonal work on farms, such as the harvesting of hay and the cleaning of the turnip crop, was done under difficulties, while the crops and live stock generally made slow progress. The conditions were, however, favourable for the growth of roots and pastures. In most western districts the weather during August was mainly fine and bright. In south-western districts the first and last weeks were generally dry and sunny, although the remainder of the month was wet and stormy. Throughout practically all eastern and south-eastern districts, however, and particularly in the neighbourhood of the Firth of Forth, the first three weeks of the month were almost continuously wet, cold and sunless. In this area the development of the crops was retarded, the hay harvest was delayed, and a considerable proportion of the grain crops was lodged. During the last few days of August dry and genial conditions were general all over the country and the crops showed considerable improvement.

The wet weather during June helped to stimulate the growth of the wheat crop, and at the end of that month the plants were generally reported to have a strong and healthy appearance. In the principal wheat-growing districts at the end of July the crop was reported to be up to the average as regards vigour and healthiness, and a satisfactory yield was then expected. Ripening was delayed by the adverse conditions during August, and at the beginning of September it was apparent that harvest would not become general before the second week of the month. In the Lothians and Kincardine the yield was estimated at about 5 per cent. above the average, but in parts of Angus, Fife and Perth the forecasts indicated yields slightly below the normal; in North-East Angus it was thought that the produce of the crop would be about 10 per cent. below the average of the last ten years.

Barley generally made fair progress during the month of June, but on cold, heavy land the crop was at first reported to be rather stunted and thin on the ground. The heads filled fairly well during July and August and the crop showed a good length of straw, but portions of it were badly lodged and twisted. In a few early districts cutting commenced during the last two weeks of August. The grain ripened irregularly, however, and in some areas it was expected that harvest would not be in full swing before the middle of September. A crop 5 per cent. above the normal was anticipated in the Lothians, Kincardine, South-West Angus and North-East Aberdeen, while an average yield was expected in several eastern and north-eastern districts. In seven reports received from the eastern counties, however, the estimates of the harvest varied between 5 and 10 per cent. below the normal. The reports on the bere crop were uniformly satisfactory. At the end of August harvest was already in progress in a few scattered districts. In five districts the yield was expected to be about 10 per cent. above the normal, while fully average yields were anticipated in the other areas where this crop is grown.

The reports on oats were fairly satisfactory. During the early summer months, however, in some districts, more especially on heavy clay soils and where grown after turnips, the plants had an indifferent appearance. In the eastern counties a large proportion of the crop was lodged. Cutting was fairly general in several south-western counties during the last week of August, and was expected to commence in most of the eastern districts before the middle of September; in the north it seemed probable that the work would be delayed until the last week of September. Harvesting was unusually difficult owing to the lodging of the crop. Reports from fifteen districts, most of which are in the west and north, indicated that the crop might be from 5 to 10 per cent. above the average, while seventeen reports forecast an average harvest; in ten districts the estimates of the yield were from 5 to 10 per cent. and in Roxburgh and Selkirk 15 per cent. below the normal.

Beans flowered well and showed a good growth of straw, but the lack of sunshine retarded the development of the pods, and at the beginning of September it became apparent that harvest would be later than usual. The estimates of the yield were rather above the average.

Potatoes generally made slow progress during June and July, and at the beginning of August in most of the eastern counties and in Stirling, Dumbarton and North Ayr the haulms were reported to be stunted and somewhat lacking in vigour. The forty-two reports on the crop received at the end of August showed considerable variation. In the north main-crop potatoes were generally growing well and there were prospects of a good average harvest. In eastern districts blight was prevalent and the estimates of the yield were, in consequence, somewhat below the normal. In the western and south-western counties, however, blight was widespread, especially among certain varieties, and in some districts it was expected that the yield would be seriously affected. Where the plants were sprayed the blight had spread less rapidly, but unfortunately spraying is not generally practised. The disease was checked by the spell of dry weather that was general at the end of August, but in exposed districts further damage to the crop was then caused by night frosts.

The sowing of turnips and swedes was practically completed by the end of June, and where they had been sown early the work of singling was then in hand. Taking the crop as a whole the roots did not bulb so well as might have been expected, while weeds were reported to be more prevalent than usual. Before the end of August finger-and-toe was prevalent in most eastern districts. On the basis of the information received, however, it was thought that the yield would probably be up to the average. Mangolds were affected by the wet conditions and developed rather slowly, but at the beginning of September they showed promise of a fairly good crop. The growth of sugar beet was very appreciably retarded by the lack of sunshine and it was anticipated that the yield would be rather disappointing.

The lack of sunshine during July also adversely affected orchard and small fruits and the crops ripened slowly. Strawberry disease again caused damage in Lanark, while in South-East Perth the prospects of a heavy yield of raspberries were impaired by rainstorms. The small-fruit harvest was practically finished at the end of August. In most cases the yield was up to the average, and in South-East Perth the berry crop was somewhat heavier than usual. As a result of a rise in prices most, if not all, of the raspberry crop was picked. In South-East Lanark the yield of small fruits was considerably less than had been anticipated. It was generally expected that the yield of tree fruits would prove to be smaller than average.

Pastures continued fresh and luxuriant throughout the summer months, but the quality of the herbage generally deteriorated in consequence of the wet weather. Grazing cattle made slower progress than usual, but dairy cows were reported to have thriven well in almost every district. In Dumbarton and Dumfries mastitis caused a considerable amount of trouble with calving cows. In northern and western areas sheep on arable farms made good progress. Several complaints were received from the eastern and southern counties, however, that the flocks had been affected with maggots and foot-rot. Store lambs, when marketed, were generally small and lacking in bloom. Hill sheep have thriven quite well, but their condition at the beginning of September was rather below the average for the season of the year.

Stocks of bees were reported to be fairly strong and no reports of disease were received. Clover was plentiful, but as a result of the wet conditions the yield of clover and flower honey was exceptionally small. With the improvement in the weather at the end of August the prospects for heather honey were more satisfactory.

The supply of both regular and casual workers appears to have been adequate for requirements generally. For several weeks dairy workers were scarce in Renfrew, while casual labourers for harvest were short of requirements in Kirkcudbright.

SCIENCE AND PRACTICE.

The following extracts and summaries are supplied by members of the staffs of Scottish agricultural colleges and scientific institutions or are taken from recent bulletins of the International Institute of Agriculture. Full references to the original publications may be obtained on application to the Secretary, Department of Agriculture, York Buildings, Edinburgh.

CROPS AND SEEDS.

Germination of Damaged Seeds. *From Nature, No.* 3225, *Vol.* 128.—How much a seed can be damaged without seriously affecting the resulting plant has been a matter of controversy since the inception of seed testing, and the question has been recently investigated by the British Association of Commercial Seed Analysts. New seed of species of *Brassica* may be damaged in a variety of ways; the testa may be lost or cracked, or the seed may be partially sprouted or attacked by weevils, and yet show a germination of 75 to 100 per cent. Yearling seed, however, gave less satisfactory results. In the case of timothy, although badly damaged seed was of little value, that which was only slightly eaten showed a 56 per cent. germination, and it seems possible that a satisfactory line of demarcation may be drawn between good and useless seed. As regards leguminous seeds, lucerne is the least susceptible to damage, more than 80 per cent. germination being recorded, except in those cases where fracture had occurred at the junction of the cotyledons and radicle. Trefoil, alsike and white clover, with seeds damaged in a similar manner, gave distinctly lower germination. The most striking results, however, were obtained with maple peas, even severely damaged seeds giving a 78 per cent. germination, of which 56 yielded mature plants. Soil tests carried out with new swede seeds, the testas of which were either entirely or partially missing, showed even up to 97 per cent. germination, failure only occurring where injury to the radicle was excessive. It would seem, therefore, that some revision in the use of the term "impurities" in the case of such seeds is necessary.

Trials with Different Red Clover Strains in 1918-1929 at the Ultana Branch Station of the Swedish Seed Association. *By Rob. Torssell, Sveriges Utsädesförenings Tidskrift, Argang* XXXXI, *Häfte* 3, 1931. *(From the writer's English summary.)*—Comparative trials were made of early, broad-leaved (Silesian) red clover, pure-bred Swedish late red clover (pure-bred late of Svälof and of Weibull and Holmberg's Göta red clover), and so-called local strains, mostly of the late type, from farms in different parts of the country. These latter strains had usually been grown on the respective farms for a very long series of years, and had thus been adapted for the local soil and climatic conditions.

Even in the first harvest year the broad leaved red clover was decidedly inferior to the late Swedish red clover. The pure-bred strains yielded somewhat better in the first harvest year but somewhat less in the second than the local strains of the vicinity.

The local strains of northern and middle Sweden have an essentially better winter hardiness than the pure-bred strains. Broad leaved (Silesian) red clover was, amongst all the strains tested, by far the lowest in winter hardiness.

The local strains tested for a long series of years with good results ought to be propagated and distributed in Uppland and probably also in adjacent provinces instead of commercial late red clover.

The Chemical Composition of Grass from Plots Fertilised and Grazed Intensively in 1929. *By J. G. Archibald, Journal of Agricultural Research, Volume* 41, *No.* 6, *September* 15*th*, 1930.—The most striking feature of the fluctuations in dry-matter was the remarkable rise in percentage content as the season advanced, more especially in the check and no-nitrogen plots. This was a direct and immediate result of the very dry season.

Fluctuations in percentage content of nitrogen showed the same general trend as in 1928. The completely fertilised plots were consistently higher than the no-nitrogen plots. As the season advanced there was a quite uniform increase in the percentage content of crude fibre on all the plots until August, and on the check and no-nitrogen plots until September. Further confirmation was obtained of the conclusion arrived at in 1929 to the effect that while grass may be kept short by grazing, it does not follow that it will have a uniform composition and nutritive value throughout the season.

Fertiliser treatment decreased considerably the dry matter content of the grass and the crude fibre content of the dry matter. The conclusion is reached that of all the factors that influence the chemical composition of grass, producing as they do marked seasonal fluctuations, the amount of rainfall is the most important.

Variation within and between Morphological Varieties of Oats. *By R. G. Wiggins, Cornell University Agricultural Experiment Station, Bulletin* 94, *July* 1930.—The writer studied the variation in yield and adaptation of varieties of oats and barley. The material for this study in general was composed of varieties that were fairly well adapted to New York conditions. A group of ten varieties of oats and eleven varieties of barley of morphological difference remained after the preliminary selection.

The wide range of variation found within and between varieties and the wide seasonal variation present a great opportunity for improvement in both oats and barley. In general, the greater the variation between strains within morphological variety, the greater is the opportunity for improvement by the selection of the best strain. A few varieties of both oats and barley seemed to exist as pure lines, and further selection probably would serve only to maintain their present status. It is easier to find a low-yielding strain of a variety than to obtain the highest yielding strain. Many varieties with distinct possibilities for improvement and real adaptability have probably been discarded because a low-yielding strain of the particular variety has been obtained and used for testing.

SOILS.

Utilisation of Peat for Fuel in Russian Power Station. *From Nature, No.* 3227, *Vol.* 128.—A large and interesting power station which utilises peat for fuel is operating at a distance of 75 miles from Moscow. It is called the Shatura power station, and is situated near three small lakes lying close together, and adjoins an immense peat bog. The present operations cover about 50 square miles. There are three large boiler-houses fitted with chain grate stokers specially adapted for burning peat. The turf is supplied in two forms, sods and dust, the dust dropping on the top of the sods in the furnace. The latest boiler put in is made to burn turf dust only; it has a number of oil burners to heat up the furnace before commencing, but has no chain grate. The present way of collecting the turf is by means of powerful hydraulic hose jets which play on the turf and wash it down into an excavated pit as a wet sludge. It is pumped out of this on to the fields, where it is left to dry. Then a slicer on a caterpillar tractor runs over the field, cutting the turf into sods and turning it over. A year's turf has to be collected and dried in four or five months. It is stated in an article by F. C. Wigham in the *Electrical Times* of August 13 that other work must be found in the winter for the 5,000 men employed on the turf field. The turf work is a separate business from the electric works and sells its product to the latter at a profit. All industries in Russia must now earn 6 per cent. on the capital employed. In the annual report it is stated that 920,000 tons of turf were consumed last year, the cost of the turf in the bunkers being a little more than 11 roubles per ton, the par value of the rouble being 2*s*. 1*d*. and its purchasing value being about half as much. The power is transmitted to Moscow at 115,000 volts, and the cost per unit last year was 2·20 kopeks, a kopek being equal to ¼*d*. In every five days half the head staff are away on holiday on one day and the other half on another day.

The Availability of the Nitrogen in Farm Manure under Field Conditions. *A. Floyd Heck. Soil Science, XXXI* (1931), 467-481.—The author of this contribution issued from the University of Wisconsin, published in *Soil Science*, XXXI (1931), 335-363, a paper on the "Conservation and Availability of the Nitrogen in Farm Manure" (see Review in *Scottish Journal of Agriculture*, July 1931) in which he showed that little other than the liquid manure or ammonia nitrogen is available for plant growth. The greater part of work done on this subject has been conducted in the laboratory or greenhouse, and reliable field data are not so plentiful. Most of the field data with farm manure are reported in acre yields from a given application of manure in tons per acre, and as a rule neither the amount of nitrogen recovered in the crop nor the amount and kind of nitrogen added in the manure are reported. Where percentage nitrogen recovered in the plant is recorded the recovery varies from nothing to as much as over half the total nitrogen in the manure. This variation is no doubt due to the variation in the quality of the manure and also to the way in which it was handled in its application.

The present contribution describes a field study of the availability of the nitrogen in farm manure conducted with spring barley. Fermented and fresh cattle manure and artificial manure were used; dung and liquid manure were used alone, together, and also combined with straw as bedding. Not only was the nitrogen determined in the manures applied, but also in the total crop—tops, roots and stubble.

The following points seem to be outstanding—the amount of nitrogen recovered in the barley crop was never greater than the amount of ammonia or liquid manure nitrogen applied. The results indicate that only the ammonia or liquid manure nitrogen is available for the first crop after the manure is applied to the soil. Little if any of the water-insoluble nitrogen in the manure is recovered in the first crop.

When liquid manure is applied alone before the crop is seeded, the recovery is less than when applied in conjunction with the dung. This difference seems to be due in part to washing out of the urea before its change to ammonia. If liquid manure is to be used alone it is perhaps best applied to the growing crop and worked into the soil at once.

Complete manure turned under immediately on spreading gives a recovery of 80 per cent. of the ammonia nitrogen which it contains. There is no difference in the availability of nitrogen between the manure fermented in storage and the fresh manure when they are turned under immediately on spreading.

Top-dressing gives a higher availability than ploughing down. The nitrification of manure top-dressed and disked in is more rapid than when it is ploughed under.

Measured in terms of non-recovery, the greatest loss of nitrogen in spreading manure and allowing it to dry or partially dry before being ploughed under occurs with manure which has ammonified but not fermented. The next greatest loss is from the completely fermented manure. The fresh manure gives a still smaller loss under these conditions, and where the fermented manure is spread just previous to a rain the loss from drying is not more than a few per cent. The better the conditions for drying and the greater the proportion of the nitrogen in the form of ammonium carbonate, the greater the loss of nitrogen in handling, spreading and subsequent drying.

The addition of straw to manure decreases the amount of nitrogen recovered in the first crop. Six per cent. of straw used as bedding in the manure reduced the recovery more than 20 per cent. Wood shavings used as an absorbent are even more detrimental than straw. The depressing effect of these substances is due to the use of ammonia and nitrate nitrogen by soil fungi, which at the same time use certain carbonaceous materials in the straw or shavings as energy for their growth. According to another worker on the same subject, peat as an absorbent has two distinct advantages over straw or shavings—first, it is a better absorbent and more of the liquid manure is saved and applied to the field, and, second, there is very little energy material in peat for the growth of soil fungi, and as a result the depressing effect from this source is largely eliminated.

DAIRYING.

Aroma in Butter. *Schmeidler, Chimie et Industrie* 24 (3), 1930.—According to the result of recent researches it is now possible to ensure the desirable butter aroma by the incorporation in the newly churned butter (or in other edible fats) of a definite chemical substance called diacetyl. Dutch investigators state that one may find traces in milk of the parent substance, acetyl methyl carbinol, which by oxidation gives rise to diacetyl. This oxidation appears to be effected by ferments or by catalysts. Butter made in the usual way contains a varying amount of diacetyl, a circumstance which appears to depend on the season of the year and on the food of the cows. Further, the aroma developed in margarine by the addition of sour milk is also variable. By the addition of acetyl methyl carbinol or directly by adding diacetyl one may overcome this defect, and margarine manufacturers can thus regulate the quality of their product.

ANIMAL BREEDING.

Cattle.

Dairy Work at the Huntley Field Station. *U.S. Dept. of Agric. Bull.* 116, *June* 1929.—Many aspects of dairy husbandry are discussed as a result of the work which has been conducted at this farm since 1918. It was found that fewer services were required per conception if cows were on pasture than if they were store fed, especially for those cows which required three or more services per conception. Some difficulty was experienced in getting first calf heifers to settle to the bulls. The heifers had been on pasture only about two months during the first two years. Accordingly it was decided to feed sprouted oats, to which reference has already been made in these abstracts. Five cows and heifers which had refused to settle to the bull conceived within 40 days after the feeding of the sprouted oats had been begun.

There are also some interesting notes on the changes in weight of cows during pregnancy. The average weight of 53 cows at date of service was 1,150 lb. This increased till at time of calving the weight was 1,435 lb. and at one day after calving it was 1,280 lb. The average weight of the calves born was 97 lb., the heifers being 90 lb. and the bull calves 98 lb. A gradual increase was found in both heifer and bull calves as their dams increased in size up to 1,500 lb. Therefore increase in size of the dam did not appear to be correlated with size of the calf.

Length of Calving Interval and Average Milk Yield. *By W. L. Gaines and J. R. Palfrey.* 1931. *Jour. Dairy Sci., Vol.* 14, *No.* 4, *pp.* 294-306.—In this paper the term "calving interval" refers to the period from one calving to the next. In practice this is usually rather over a year. The writers deal with the effect of the length of calving interval on the average milk yield. The data upon which this study is based are those of Langmack and are confined to 186 Red Danish cows whose records in each case start with the cow's first calf and continue uninterruptedly throughout the nine following calvings. The yield is considered on an energy basis in terms of 4 per cent. milk as already described by Gaines. The authors find a negative correlation between calving interval and yield over the current calving interval, and a positive correlation between calving interval and yield over the following interval. The authors state that if it is desirable to change the time of year of calving it appears that the calving interval might be prolonged to 18 months without adversely affecting the average yield per day, considered over both the current and following intervals.

The Hemoglobin and Total Phosphorus in the Blood of Cows and Bulls. *By C. M. M'Cay.* 1931. *Jour. Dairy Sci., Vol.* 14, *No.* 4, *pp.* 373-378.—The cows studied included 38 Holsteins, 8 Ayrshires, 10 Guernseys, and 13 Jerseys. Over a thousand determinations were made, and those show that the blood of a normal cow contains 10·9 gms. of hemoglobin per 100 c.cs. of blood, whereas the blood of mature bulls contains 12·8 gms. The writers found no relation between the hemoglobin of the cow and any of the following:—Breed, milk production, fat production, length of lactation period, or any period of gestation or lactation. Neither were any differences found in the total phosphorus, iron and hemoglobin in the blood of 74 cows at the close of the winter months and after a two months' period of exposure to pasture or sunshine.

Sheep.

Linkage Studies in Sheep. *By Boris Wassin.* 1931. *Jour. Hered., Vol.* 22, *No.* 1, *pp.* 9-13.—This paper deals with the inheritance of three characteristics of, as yet, no great economic importance. Additional nipples, which are usually non-functional and are placed in front of the basic pair, depend upon the presence of a dominant gene. At the same time there is a dominant inhibitor which may completely mask the effect of the multi-nipple gene. There are also modifying factors which increase the total number of nipples beyond four.

Wattles or tassels are found most commonly in goats, but are also known in sheep and pigs. These again are inherited in a dominant manner, but again a ram was found who in his breeding behaved as though he had wattles but did not bear any trace of them. One might suggest to the author of the paper the possibility that the wattles were taken off at the first shearing.

The remaining characteristic described is a white necklace which is again inherited as a simple dominant. The author discusses the possibility of linkage. The figures are not very large and the results are not conclusive.

Inbreeding Sheep. *New Hampshire Agric. Exp. Stat. Bulletin* 250, *pp.* 20 *and* 21.—Constant inbreeding over a period of fifteen years during which no outside blood was introduced for seven generations resulted in a material decrease in the size of the sheep, and this in spite of constant elimination of under-sized offspring. The fertility rate has however increased, the percentage of twins born in the later generations being considerably greater. The authors accordingly state that this may in part be responsible for the decrease in size due to lack of sufficient milk for the support of two lambs.

In an effort to increase the number of nipples in sheep an effort has been made to establish a strain which possesses four functional nipples. Higher milk yielding capacity seems to be associated with this multi-nipple trait, but the majority of the offspring possessed only two functional nipples. To date only six females have been obtained with four functional nipples.

Further data are produced on crossing coarse wool by fine wool breeds. The result is a kind of blending. It has become apparent that attempts to improve the quality of wool require constant selection and weeding out of undesirable characters if the intermediate characters are to become stabilized as blends which will be transmitted as such.

Pigs.

Report on Progeny Performance Test of Boars of Danish Landrace Breed. *By J. Jespersen and M. P. Osterlund Madsen. Bulletin Royal Vet. and Agric. Coll., Copenhagen* (1929).—Three principal characters are considered in this report, which is very full and includes large numbers of figures and graphs. These are body length, thickness of belly and thickness of back fat. The study covers 77 boars, each having from 5 to 20 litter groups which have passed through the testing station. Each litter group consisted of four pigs, but it does not always consist of two males and two females, and in some of the litter groups owing to the death of one pig the records are not complete. It must be considered also that there is a possibility that the best animals are not always submitted to test, but are retained for showing and breeding. Also there is seldom more than one litter tested from each sow, particularly if the first litter is above par, and therefore the maternal influence on the record of the progeny of any particular boar can only be estimated. The writers find a positive correlation of 0·2 between thickness of belly and thickness of back fat, while there is a negative correlation between length and thickness of back. The long animal has a thin back and a fine shoulder, and therefore length is a useful point for which to select. The writers state that this character is not greatly affected by nutrition or environment.

There then follows an interesting pedigree analysis of famous animals which have made the Danish Landrace breed what it now is, and a rough outline of the inheritance of economic characters is traced.

INSECTS AND PESTS.

Coloured Glass as a Deterrent to House Flies. *From Nature, No.* 3224, *Vol.* 126.—An interesting series of tests with the object of finding whether rooms glazed with "Calorex" are likely, by virtue of the special properties of the glass, to be freer from insects than rooms glazed with ordinary glass has recently been carried out at the Imperial College of Science and Technology under the supervision of Prof. J. W. Munro on behalf of Messrs. Chance Brothers & Co., Ltd.

Calorex glass is of a pale greenish-blue tint, and is designed to afford protection from excessive solar radiation by strongly absorbing infra-red radiation whilst transmitting in a useful degree the radiation within the visible spectrum. The present experiments, which have been conducted with several types of insect, but mainly with flies, bees and wasps, confirm and amplify observations made at the Building Research Station at Garston, Herts, and described by Mr. H. E. Beckett in *Nature.*[1]

House flies (*Musca domestica*) exposed to sunlight in a box, one half of which was glazed with Calorex and the other with ordinary glass, showed a marked preference for the ordinary glass, the ratio of the numbers of insects in the two halves, averaged over several experiments, being about 9 : 4. These results were verified by other tests in which the insects were not enclosed within the box but were attracted to it by a suitable bait. Wasps and bees were found to behave in the same way as flies.

Much of the preference shown is ascribed to the inequality of temperatures beneath the two kinds of glass, the disparity in insect population being greatest when the maximum temperature differences were observed. Confirmatory evidence of a positive effect with temperature differences maintained by agencies other than radiation is not, however, chronicled.

That an effect can definitely be ascribed to the colour of the light which has passed through Calorex was demonstrated by an experiment in which bees were enclosed in a glass cylinder, one end of which was closed with Calorex and the other with ordinary glass. By interchanging the glasses an immediate reaction was obtained, the bees moving to the end covered with ordinary glass.

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[1] *Nature*, 125, 780, May 24, 1930.

The effect of coloured light does not seem to be peculiar to blue light. Messrs. Pilkington Brothers, Ltd., from experiments conducted last year, have stated [1] that the house fly prefers white light to coloured light, and that red and yellow are the best deterrents, being considerably more effective than blue and green. On the other hand, it has been stated [2] that blue glass is completely effective.

The most extensive use of coloured glass for this purpose at present seems to be in meat stores. In such buildings yellow glass is unpopular on account of the sickly appearance which it imparts to the meat, and blue glass has been used with some success. In Holland the use of blue glass has, moreover, been extended to cow-houses with beneficial results. The glass, although of a distinctly different tint from Calorex, appears to share with the latter to some extent its power of absorbing the infra-red radiation of the sun, so that temperature effects may be partly responsible for the positive results obtained. The value of yellow glass cannot, however, be ascribed to such an effect. More information is obviously required on this most practical problem.

IMPLEMENTS AND MACHINERY.

New Farm Implements in Germany. *From Nature, No.* 3225, *Vol.* 128.—The farming industry in Germany is far from flourishing at the present time. Instead of this preventing the development of new industrial material, it seems, judging from the large number of new agricultural devices shown at the recent show in Hanover, to be acting as a spur to further improvements. In the *Electrician* for July 31, R. Borlase Matthews describes some of the novel machines shown at this agricultural exhibition. Manufacturers are providing machines likely to reduce the costs of production, and the farmer is doing everything to increase the cultivated area and farm the land more intensively, so as to lower the total cost per unit produced. The number of new implements shown was nearly 200, and there were 5,300 machinery exhibits, numbers which far surpass anything seen at shows in Great Britain. Electrically operated apparatus was very much in evidence, large scale demonstrations being given of equipment suitable for dairying, poultry-keeping, &c. An ingenious device known as the " rain-cannon " is used for watering fields. It consists of a jet mounted on a cylindrical pressure tank. The upper portion of the tank is filled with air, which is compressed by the water until there is equilibrium. When this is attained a valve situated in the nozzle opens an orifice. Owing to the sudden release, the air pressure ejects the water in a powerful jet to a considerable distance and at the same time moves it round slightly. This method is a great improvement on the old sprinkler and pipeline methods. A small rain-cannon requiring only a pressure of two or three atmospheres to work it was a very popular exhibit. Pneumatic transport methods for transporting hay from the barns are coming into use owing to their convenience. A device was shown which supplied concentrated feed to the horses in stables twice a day. It was entirely automatic, requiring charging only once a week.

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[1] *Nature*, 125, 529, April 5, 1930.

[2] *Nature*, 125, 780, May 24, 1930.

STATISTICS.

PRICES of AGRICULTURAL PRODUCE, FEEDING STUFFS and FERTILISERS in June, July and August, 1931.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	June.			July.			August.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
FAT STOCK :—									
*CATTLE—	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.	per cwt. s. d.
Aberdeen-Angus ...	60 5	51 5	42 3	63 2	55 0	40 11	58 11	52 8	42 0
Cross-bred (Shorthorn)	57 5	48 10	37 2	60 0	52 0	39 7	55 3	48 10	38 5
Galloway	53 6	49 3	...	55 0	50 6	...	52 1	48 5	...
Ayrshire	56 3	43 0	32 8	54 10	44 0	33 7	51 0	43 3	33 3
Blue Grey	...	...	...	54 3	...	...	50 6	...	...
Highland	50 0	...	...	...	...	...	...	...	...
	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
†VEAL CALVES	16¾	9	...	13¾	9	...	13	9	...
	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.	Hoggs under 60 lb.	60 lb. and upw'd.	Ewes.
†SHEEP—	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
Cheviot	14¼	12¾	9¼	13¾	12¼	8¾	12	10¼	8
Half-bred	13¾	12¾	8¾	13¼	12¼	8	11¾	10½	7½
Blackface	13¾	12½	9	13	12	8½	12	10½	7¾
Greyface	14	12¾	9¾	13½	12½	9	12	10¾	7½
Down Cross	14¼	12¾	7½	13¾	12½	6½	12	10½	7
†PIGS—	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.	per stone. s. d.
Bacon Pigs	10 4	9 4	...	9 6	8 6	...	9 7	8 6	...
Porkers	11 7	10 6	...	10 5	9 3	...	10 8	9 7	...

* Live weight. † Estimated dressed carcase weight.

LIVE STOCK : Monthly Averages of Prices at certain representative Scottish Markets—(*continued*).

Description.	JUNE.			JULY.			AUGUST.		
	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality	1st Quality	2nd Quality	3rd Quality
STORE STOCK :—									
CATTLE—	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.	Per head.
Aberdeen-Angus :	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Yearlings	17 16	13 9	12 5	18 3	13 11	12 5	16 2	12 16	12 0
Two-year-olds ...	22 7	16 17	15 3	21 16	17 5	16 0	22 0	16 15	14 13
Cross-bred (Shorthorn):									
Yearlings	16 9	13 10	11 0	17 19	13 9	11 2	14 8	11 16	10 15
Two-year-olds ...	21 7	16 6	14 13	20 9	16 16	14 15	20 12	16 7	14 10
Galloway :									
Yearlings	14 3	...	...	13 3	...	...	14 5	...	...
Two-year-olds ...	...	17 18	...	19 10	...	...	...	17 15	...
Ayrshire :									
Yearlings	11 13	...	...	11 17	...	...	...	...	..
Two-year-olds ...	...	...	...	18 5	16 10	...	...	...	...
Blue Grey :									
Yearlings	...	...	...	...	...	...	...	...	...
Two-year-olds ...	...	...	...	...	...	...	...	...	...
Highland :									
Yearlings	12 6	10 3	8 8	9 5	...	6 10	...	...	...
Two-year-olds ...	14 13	13 0	11 0	12 10	...	10 10	...	...	...
Three-year-olds ...	21 0	16 11	15 0	...	15 0	12 5	...	...	...
DAIRY COWS—									
Ayrshire :									
In Milk	24 19	17 3	12 0	26 3	20 6	12 5	28 8	19 14	12 0
Calvers	25 9	19 13	14 0	27 4	20 11	14 8	25 17	19 12	14 8
Shorthorn Cross :									
In Milk	27 18	20 13	...	32 14	26 7	21 0	31 0	22 16	...
Calvers	30 0	21 3	14 18	31 2	22 4	16 6	29 6	21 5	17 0
SHEEP—	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Cheviot Hoggs ...	38 3	28 2	...	41 5	36 3	...	33 9	...	...
Half-bred Hoggs ...	57 1	44 6	...	45 9	45 0	...	64 0	...	...
Blackface Hoggs ...	41 4	27 5	16 6	40 0	30 0	...	31 6	...	...
Greyface Hoggs ...	48 9	39 3	29 0	44 0	34 0	...	40 0	32 0	...
Down Cross Hoggs ..	51 0	...	...	...	...	...	...	...	...
PIGS—									
(6 to 10 weeks old)	33 10	21 7	...	29 5	18 10	...	27 2	17 0	...

DEAD MEAT: Monthly Average Prices at Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Quality.	June.			July.			August.		
		Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.	Dundee.	Edinburgh.	Glasgow.
		per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.	per lb. d.
BEEF:—										
Home-fed—										
Bullock or Heifer ...	1	9⅛	9¼	10⅜	9¾	10⅛	10⅞	9½	9½	10⅝
	2	8⅝	...	9⅜	9¼	...	9⅞	9	...	8⅞
Bull	1	7⅛	7⅛	6¾	7¾	7	7	7¾	6⅞	6⅞
	2	6⅝	...	5⅞	6¾	...	6½	7	...	6
Cow	1	6	6	6⅛	6¾	6¼	6⅛	6	6¼	6
	2	5¼	...	5⅜	5¾	...	5⅜	5	...	5
Irish—										
Bullock or Heifer ...	1	...	...	9	...	...	9	...	...	8½
	2	...	...	8	...	...	8¼	...	...	7⅝
Argentine Frozen—										
Hind Quarters ...	1	4¼	5¾	...	4⅛	6¼	...	4⅝	6¾	...
	2	...	3¾	...	...	3⅞	...	4½	4	...
Fore ,, ...	1	3⅛	3½	...	2⅞	3¼	...	3⅜	3½	...
	2	...	2⅞	..	...	2⅝	...	3¼	3	...
Argentine Chilled—										
Hind Quarters ...	1	6⅝	6⅞	7	6⅞	6⅞	6¾	7¾	8	7¾
	2	5⅞	6	6⅛	6⅛	5½	5⅞	...	7¼	6⅝
Fore ,, ...	1	3½	3¼	2⅞	3½	3¼	3	4	4	4
	2	3¼	2⅞	2⅜	2½	2⅞	2½	...	3¾	3½
Australian Frozen—										
Hind Quarters ...	1	...	...	4⅛	...	...	4	...	...	3¾
	2	...	...	...	...	...	...	...	...	...
Crops	1	...	...	3⅛	...	...	3	...	...	2⅞
New Zealand Frozen—										
Hind Quarters ...	1	...	...	4⅛	...	...	4	...	...	3½
	2	...	...	...	...	...	...	...	...	...
Fore ,, ...	1	...	...	3	...	...	2¾	...	...	2⅝
	2	...	...	...	...	...	...	...	...	...
MUTTON:—										
Hoggs, Blackface ...	under 60 lb.	12¾	12¾	13¾	13	12½	12¾	13	10⅞	11⅛
	60 lb. & over	11¾	...	12⅜	12	...	11⅝	12	...	10⅛
,, Cross	under 60 lb.	12¾	12¾	13¾	13	12½	12¾	13	10⅞	11⅛
	60 lb. & over	11¾	...	12⅜	12	...	11⅝	12	...	10⅛
Ewes, Cheviot	1	...	8½	10	...	8¼	9⅜	...	7⅜	7⅝
	2	...	...	9½	...	...	8¾	...	...	7
,, Blackface ...	1	8⅞	8½	10	9⅜	8¼	9⅜	9	7⅜	7⅝
	2	7⅛	...	9½	8¾	...	8¾	8	...	7
,, Cross	1	7	8½	10	6	8¼	9⅜	6	7⅜	7⅝
	2	6⅜	...	9½	5	...	8¾	5	...	7
Argentine Frozen ...	1	...	...	4¼	...	...	4½	...	...	5
	2	...	...	...	...	...	...	...	...	...
Australian ,, ...	1	...	5⅝	3⅞	...	5⅛	4¼	...	5⅛	4¾
	2	...	4¼	...	...	3¾	...	...	4	...
New Zealand ,, ...	1	...	...	4⅝	...	...	4¾	...	...	5⅛
	2	...	...	4¼	...	...	4¼	...	...	4¾
LAMB:—										
Home-fed	1	16	15⅛	18	14⅜	18½	14¼	...	12	11⅝
	2	...	...	13¾	...	...	12¼	...	...	10½
New Zealand Frozen ...	1	...	8⅛	7¾	...	8⅛	7¾	...	8⅛	7⅝
	2	...	7½	7	...	7⅛	7	...	7	7¼
Australian ,, ...	1	...	...	7	...	...	7	...	...	7
	2	...	...	...	...	...	...	...	...	...
Argentine ,, ...	1	...	...	6	...	...	6	...	...	6
	2	...	...	5⅝	...	...	5¾	...	...	5¾

Eggs: Monthly Average Wholesale Prices at Aberdeen and Glasgow. Provisions: Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

Market.	Description.	Quality.	June.		July.		August.	
			s.	d.	s.	d.	s.	d.
Aberdeen.	Country ... ... per doz.	1	0	11	1	2	1	5
		2	0	10	1	1	1	4
	Duck ... ... ,,	1	1	0	1	3	1	5
		2	0	11	1	2	1	4
Glasgow.	Country .. ... per doz.	1	1	1	1	4	1	7
		2	1	0	1	3	1	5
	Irish ... ... per 120.	1	10	3	13	11	13	8
		2	8	6	11	1	11	11
	,, (Duck) ... ,,	1	8	4	8	1	10	5
		2	...		7	0	10	3
	Belgian ... ... ,,	1	8	6	9	5	10	10
	Danish ... ... ,,	1	8	8	9	4	10	4
	Dutch ... ... ,,	1	...		9	10	9	10
	Polish ... . ,,	1	6	4	6	9	6	5
	,, ... ,,	2	5	5	5	7	5	7
	Swedish ... ... ,,	1	...		9	2	9	5

Description.	Quality.	June.		July.		August.	
		s.	d.	s.	d.	s.	d.
BUTTER:							
Irish Creamery ... ... per cwt.	1	116	6	115	6	119	0
,, ,, (Unsalted) ,,	1	120	6	119	6	123	0
Australian ... ... ,,	1	115	6	115	0	...	
Canadian ... .. ,,	1	...		112	8	114	0
Danish ... ... ,,	1	122	2	123	0	125	3
,, (Unsalted) ... ,,	1	126	0	127	2	129	9
New Zealand ... ... ,,	1	117	3	118	0	119	9
,, (Unsalted) ... ,,	1	...		...		125	0
Siberian ... ... ,,	1	...		...		104	0
Swedish ... . ,,	1	119	3	116	7	120	3
CHEESE:							
Cheddar ... ... ,,	1	94	3	92	0	73	0
,,	2	88	3	87	2	69	0
Cheddar Loaf ... ... ,,	1	...		102	0	86	6
Dunlop ... ... ,,	1	91	9	87	2	66	6
,,	2	84	0	56	0	61	0
Canadian... ... ... ,,	1	84	6	73	2	66	3
New Zealand (Coloured) ,,	1	60	9	64	10	68	6
,, (White) ,,	1	58	6	62	2	66	0
HAMS:							
Irish (Smoked) ... ... ,,	1	158	3	147	0	147	0
,, ,,	2	144	0	135	0	135	0
American, Long Cut (Green) ,,	1	88	0	87	10	89	6
,, Short Cut ... ,,	1	73	3	80	2	85	6
BACON:							
Ayrshire (Rolled) ... ,,	1	111	0	106	5	104	0
Irish (Green) ... .. ,,	1	96	0	94	0	95	0
,, (Dried or Smoked) ,,	1	102	0	101	2	103	6
,, (Long Clear) ... ,,	1	96	0	95	7	92	6
Wiltshire (Green) ... ,,	1	103	6	106	5	107	0
,, (Dried or Smoked) ,,	1	109	6	116	5	115	0
Danish, Sides ... ... ,,	1	62	0	67	2	73	0
Dutch, Green (Wiltshire Style) ,,	1	54	0	60	5	72	3
American (Short Clear Backs) ,,	1	81	0	81	0	80	6

FRUIT AND VEGETABLES : Monthly Average Wholesale Prices at Glasgow.

(Compiled from Returns received from the Department's Market Reporter.)

Description.	Quality.	JUNE.	JULY.	AUGUST.
FRUIT :—				
Apples—		s. d.	s. d.	s. d.
American ... ... per case.*	1	...	14 0	12 8
American ... ... per barrel.†	2	...	...	16 0
Australian ... ... per case.*	1	12 11	...	13 10
New Zealand ... ,, ,, *	1	14 8	12 11	...
Pears, Australian ... per case.*	1	16 9	...	...
,, French ... ... per lb.	1	...	0 6	0 2½
Gooseberries, British ... ,,	1	0 2	0 1½	0 1¾
Strawberries, Scottish ... ,,	1	...	0 5	0 5¼
,, English ... ,,	1	0 6	0 5¼	...
Currants, Black ... ,,	1	...	0 5¾	0 5¼
,, Red ... ... ,,	1	...	0 5	0 4¾
Raspberries ... ... ,,	1	...	0 4½	0 5¾
Greengages, British ... ,,	1	...	...	0 6½
,, Imported... ,,	1	...	0 4½	0 5¼
Plums, British, Victoria ,,	1	...	...	0 8
VEGETABLES :—				
Beet ... ... per cwt.	1	4 9	4 0	‡3 9
Cabbage, Coleworts ... per doz.	1	1 2	1 2	1 9
Carrots, British... ... per cwt.	1	...	10 8	6 9
,, Dutch ... ... ,,	1	‡4 6	‡3 3	4 8
Cauliflowers, British ... per doz.	1	4 3	4 5	4 11
,, Dutch ... ,,	1	3 4	2 7	...
Celery ... ... per bunch.	1	...	...	2 11
Cucumbers ... ... per doz.	1	6 0	4 2	4 2
Leeks ... ... per doz. bunches.	1	...	..	4 6
Lettuce, Cos ... ... per doz.	1	1 3	1 7	1 2
,, Cabbage ... ,,	1	1 3	1 11	1 1
Mushrooms ... ... per lb.	1	...	1 6	0 10
Onions, *Spring* ... ... per bunch.	1	0 4¾	0 6¼	0 4½
,, *Egyptian* ... per cwt.	1	13 5	13 0	10 0
,, *Dutch* ... ... ,,	1	...	...	6 0
,, *Valencia* ... per case.†	1	13 5	13 1	9 0
Parsley ... ... per cwt.	1	12 0	12 10	12 0
Parsnips ... ... ,,	1	6 8	...	10 0
Peas ... ... ,,	1	...	20 0	18 0
Radishes ... ... per doz. bunches.	1	1 8	1 6	1 6
Rhubarb ... ... per cwt.	1	1 11	2 0	3 3
Spinach ... ... per stone.	1	4 0	4 0	4 0
Tomatoes, *Scottish* ... per lb.	1	0 9½	0 6½	0 5¾
,, *English* ... ,,	1	0 7	0 6¼	...
,, *Channel Islands* ,,	1	0 6½	0 5	0 4
,, *Dutch* ... ,,	1	0 6	0 4	0 3
Turnips ... ... per cwt.	1	4 0	‡3 1	4 4
Vegetable Marrows ... per doz.	1	...	3 4	3 0

* 40 lb. (approx.). † 9 stone. (approx.). ‡ per dozen bunches.

POTATOES : Monthly Average Wholesale Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	FIRST EARLIES.	SECOND EARLIES.	LATE VARIETIES.			
				RED SOILS.		OTHER SOILS.	
				Golden Wonder.	Other.	Golden Wonder.	Other.
		JUNE.					
		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Aberdeen, per ton	1	...	...	...	...	8 10 0	6 19 5
Dundee ,,	1	...	...	...	...	...	8 10 0
Edinburgh ,,	1	17 0 0	...	...	...	...	10 5 0
Glasgow ,,	1	18 0 0	...	...	...	8 16 8	7 6 8
		JULY.					
Aberdeen ,,	1	14 13 4	...	...	...	8 15 0	7 0 0
Dundee ,,	1	13 0 0	...	...	...	...	10 0 0
Edinburgh ,,	1	12 9 0	...	...	...	...	...
Glasgow ,,	1	12 4 0	..	...	...	...	...
		AUGUST.					
Aberdeen ,,	1	9 15 0	6 0 0	...	...	...	...
Dundee ,,	1	6 15 0	5 10 0	...	...	...	...
Edinburgh ,,	1	7 3 9	6 16 8	...	...	...	...
Glasgow ,,	1	7 2 6	7 0 0	...	...	..	...

ROOTS, HAY, STRAW AND MOSS LITTER : Monthly Average Prices at Aberdeen, Dundee, Edinburgh and Glasgow.

(Compiled from Returns received from the Department's Market Reporters.)

MARKET.	Quality.	ROOTS.			HAY.		STRAW.			MOSS LITTER.
		Carrots.	Yellow Turnips.	Swedes.	Rye Grass and Clover.	Timothy.	Wheat.	Oat.	Barley.	
		JUNE.								
		s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
* Aberdeen, per ton	1	...	...	...	83 9	...	...	...	...	...
‖ Dundee ... ,,	1	...	...	...	95 0*a* 85 0*b*	...	70 0	70 0	...	52 6§
¶ Edinburgh ,,	1	...	...	...	90 0*a* 90 0*b*	...	57 6	57 6	50 0	...
a Glasgow ,,	1	...	...	...	75 0	80 0	45 0	40 8	..	33 9§§
		JULY.								
* Aberdeen ,,	1	...	...	..	81 8	...	...	...	...	...
‖ Dundee ... ,,	1	...	...	...	95 0*a* 85 0*b*	...	66 0	66 0	...	50 8§
¶ Edinburgh ,,	1	...	...	...	90 0*a* 90 0*b*	...	58 0	57 6	50 0	...
a Glasgow ,,	1	...	...	...	75 0	80 0	45 0	40 0	...	33 9§§
		AUGUST.								
* Aberdeen ,,	1	...	...	...	55 0	...	...	...	...	...
‖ Dundee ... ,,	1	...	...	...	95 0*a* 85 0*b*	...	65 0	65 0	...	40 0†
¶ Edinburgh ,,	1	...	...	...	57 6*b*	...	58 9	56 3	52 6*a*	...
a Glasgow ,,	1	...	...	...	75 0	80 0	45 0	40 0	...	33 9§§

* Loose, ex farm.
‖ Baled straw, delivered.
¶ Bunched straw, delivered.
a Delivered baled.
b ,, loose.
§ Foreign moss litter, ex-quay.
§§ Home moss litter, in 1½ cwt bales.
† Granulated moss litter, at Dundee station.

FEEDING STUFFS: Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	JUNE.		JULY.		AUGUST.	
	Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.	per ton. £ s. d.
Linseed Cake—						
Home	8 2 6	7 18 9	8 4 6	7 15 0	8 3 9	7 15 0
Foreign	7 18 9	...	7 16 0	...	7 14 5	7 5 0
Soya Bean Cake ...	8 18 9	8 1 3	8 12 6	7 14 6	8 10 8	7 5 0
Decort. Cotton Cake	...	...	7 10 0	...	...	...
Undecorticated do.—						
Bombay (Home-manufactured)...	...	4 10 0	...	4 13 0	...	4 10 0
Egyptian (do.)	5 1 3	5 0 0	5 0 6	4 18 0	4 15 0	4 15 0
Palmnut Kernel Cake	6 10 0	...	6 10 0	...	6 10 0	...
Coconut Cake ...	8 10 0	...	8 10 0	...	8 7 6	...
Groundnut Cake, Undecorticated—						
(36/37 per cent. Oil and Albuminoids)	5 5 0	...	5 5 0	...	5 5 0	...
(39/40 per cent. do.)	5 8 9	...	5 7 6	...	5 7 6	...
Maize Germ Cake—						
Home	8 5 0	...	8 2 0	...	7 15 0	...
Foreign	...	...	6 15 0	...	6 15 0	...
Maize Germ Cake Meal	5 13 2	..	5 10 9	...	5 8 9	...
Rice Meal	4 18 5	4 7 6	5 0 0	4 8 0	5 0 0	4 10 0
Bean Meal	9 15 0	9 3 2	9 12 0	8 16 6	9 8 2	8 13 9
Barley Meal ...	6 5 0	5 16 8	6 6 6	5 15 0	6 8 9	6 12 6
Fish Meal	17 4 5	16 12 6	16 11 0	16 7 6	16 3 9	15 19 5
Maize Meal—						
Home-Manufactured	5 15 0	5 11 11	5 5 6	5 6 6	5 1 11	5 0 0
South African—(Yellow) ...	5 15 4	..	5 7 3	...	5 6 3	...
Locust Bean Meal ...	6 7 6	5 13 9	6 3 6	5 11 0	6 1 11	5 5 0
Maize Gluten Feed (Paisley) ...	5 15 0	...	5 15 0	...	5 9 5	...
Maize—Plate ...	4 14 1	4 11 3	4 6 0	4 7 0	4 3 5	4 0 0
Do. African, Flat	...	5 10 0	...	...	...	5 10 0
Oats—Home ...	7 14 5	7 18 9	7 8 9	7 13 6	7 13 2	7 10 0
Do. Plate ...	4 11 3	...	4 8 3	4 10 6	4 7 10	4 10 0
Do. Canadian No. 2	6 18 9	...	6 15 0	...	6 13 9	...
Do. Canadian No. 3	6 6 11	...	6 3 9	...	6 5 0	...
Barley, Feeding (Home)	5 5 4	5 0 0	5 5 9	5 0 0	5 9 5	...
Wheat—						
Home	6 14 8	5 11 11	6 11 6	5 11 6	6 14 8	5 13 9
Poultry	5 6 3	5 10 0	5 4 6	...	5 4 5	...
Imported... ...	6 9 5	6 5 0	6 8 6	...	6 11 3	...
Middlings (Fine Thirds or Parings)	6 0 0	5 16 11	6 4 6	5 13 6	6 8 2	6 0 0
Sharps (Common Thirds) ...	4 15 0	5 5 8	4 19 0	4 13 6	5 1 3	5 0 0
Bran (Medium) ...	4 8 9	4 6 11	4 11 6	4 7 6	4 12 10	4 15 0
,, (Broad) ...	4 10 8	5 6 11	4 13 9	5 5 0	4 15 8	5 13 9
Malt Culms... ...	3 18 5	...	3 18 6	3 15 0	3 15 0	3 14 5
Distillery Mixed Grains—Dried	...	6 10 0	...	6 15 0	...	7 0 0
Brewers' Grains—Dried	5 7 10	5 3 9	3 7 3	4 19 0	5 1 7	4 15 0
Distillery Malt Grains—Dried	5 15 8	...	6 5 0	...	6 11 3	...
Crushed Linseed ...	17 5 0	...	16 10 0	...	16 7 6	...
Locust Beans, Kibbled and Stoned	5 7 6	4 15 8	5 3 6	4 13 0	5 1 11	4 13 2
Beans—English ...	8 1 11	...	8 0 0	...	8 0 0	...
Do. China	8 16 8	8 10 0	8 10 0	8 5 0	7 10 0	6 12 6
Do Rangoon (White)	6 0 0	...	6 0 0	...	6 0 0	...
Pease—Russian ...	...	...	6 10 0	...	6 0 0	...
Do. Karachi ...	...	...	7 0 0	...	7 7 6	...
Do. ,, (White)	...	...	6 15 0	...	6 11 11	...
Feeding Treacle ...	5 0 0	5 7 6	4 19 6	5 7 6	4 17 6	5 7 6
Linseed Oil, per gall.	0 3 3	...	0 3 3	...	0 3 3	...

FERTILISERS : Monthly Average Prices at Glasgow and Leith.

(Compiled from Returns received from the Department's Market Reporters.)

Description.	Guaranteed Analysis.	JUNE.		JULY.		AUGUST.	
		Glasgow.	Leith.	Glasgow.	Leith.	Glasgow.	Leith.
		per ton.	per ton.	per ton.	per ton.	per ton.	per ton.
	%	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Nitrate of Soda § ...	N. 15½	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0
Sulphate of Ammonia (Neutral and Granular) § ...	N. 20·6	9 10 0	9 10 0	9 10 0	9 10 0	7 0 0	6 5 0
Nitrochalk § ...	N. 15½	9 7 0	9 7 0	9 7 0	...	8 10 3	...
Calcium Cyanamide ‖	N. 20·6	8 18 0	8 16 0	8 18 0	...	8 18 0	...
Superphosphate ...	P.A. 13·7	2 16 3	2 17 6	2 16 3	...	* 2 16 3	...
,, ...	,, 16·0	3 2 6	3 2 6	3 2 6	...	* 3 2 6	...
,, ...	,, 18·3	3 7 6	3 7 6	3 7 6	...	* 3 7 6	...
Ground Mineral Phosphate ¶	P.A. 26	2 10 0	...	2 10 0	...	* 2 7 6	...
,, ,, ,, **	,, 26	...	2 10 0	...	...	...	...
,, ,, ,, ¶	,, 34	3 10 0	..	3 10 0	...	* 3 7 6	...
,, ,, ,, **	,, 34	...	3 10 0	..	...	...	...
Potassic Mineral Phosphate	P.A. 18 Pot. 10	...	...	...	...	* 3 8 9	...
,, ,, ,,	P.A. 18 Pot. 9	3 10 0	...	3 10 0	...	3 7 2	...
,, ,, ,,	P.A. 18 Pot. 5	...	...	...	...	* 2 17 6	...
,, ,, ,,	P.A. 21 Pot. 6	3 5 0	...	3 5 0	..	3 2 2	...
Kainit (in bags) ...	Pot. 14	† 3 7 6	3 2 6	3 7 6	...	‡ 3 7 6	...
Potash Salts ...	Pot. 20	† 3 17 6	3 10 0	3 17 6	...	‡ 3 17 6	...
,, ,, ...	Pot. 30	† 5 4 0	4 12 6	5 4 0	...	‡ 5 4 0	...
Muriate of Potash (on basis of 80 per cent. purity)	Pot. 50	9 8 6	10 10 0	9 8 6	...	‡ 9 8 6	...
Sulphate of Potash (on basis of 90 per cent. purity)	Pot. 48·6	11 8 6	10 10 0	11 8 6	...	‡ 11 8 6	...
Steamed Bone Flour	N. 0·8 P.A. 28/30	4 17 6	4 10 0	4 17 6	...	4 17 6	...
Bone Meal (Home)	N. 3·3 P.A. 22·9	7 10 0	..	7 10 0	...	7 10 0	..
,, ,, (Indian)	N. 4 P.A. 19·25/28	8 0 0	7 5 0	8 0 0	..	8 0 0	...
Basic Slag †† ...	P.A. 11	1 19 0	...	1 19 0	...	1 19 0	...
,, ,, †† ...	,, 12	2 1 6	...	2 1 6	...	2 1 6	...
,, ,, †† ...	,, 13	2 4 6	*a* 1 15 0	2 4 6	...	2 4 6	...
,, ,, †† ...	,, 14	2 7 0	*a* 1 17 0	2 7 0	...	2 7 0	...
,, ,, †† ...	,, 15	...	*a* 2 1 0	...	...	...	...
,, ,, ...	,, 15	...	2 16 6	...	...	...	...

Abbreviations:—N. = Nitrogen ; P.A. = Phosphoric Acid ; Pot. = Potash.

* F.o r. Glasgow.
† Less 5*s.* 6*d.* per ton, ex-quay.
‡ F.o.r. ex-store. Less 5*s.* per ton, ex-quay.
§ Carriage paid, in 6-ton lots.
‖ Carriage paid, in 4-ton lots.
¶ 90 per cent. fineness, through prescribed sieve.
** 80 per cent. fineness, through standard 100-mesh sieve.
†† 80 per cent. citric soluble. Prices at Glasgow f.o.r., in 6-ton lots.
a Ex-Grangemouth.

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